



Innovation, Science and
Economic Development Canada

Innovation, Sciences et
Développement économique Canada

SPECTRUM MANAGEMENT AND TELECOMMUNICATIONS

A large, abstract graphic composed of multiple concentric, pixelated arcs in various shades of gray, creating a sense of motion and depth. It frames the central text.

SPECTRUM **OUTLOOK**

2018-2022

Canada

Contents

1.	Intent	1
2.	Policy objectives	1
3.	A principled approach to releasing spectrum	2
4.	Scope	4
5.	Licensing	4
5.1	Facilitating services for rural and remote communities	5
5.2	Antenna sites and structures	6
5.3	Licensing approaches for 5G services	7
6.	Demand	8
6.1	Overall demand for data	8
6.2	Commercial mobile services	9
6.3	Licence-exempt	10
6.4	Satellite	12
6.5	Backhaul	15
7.	Technology	17
8.	Frequency bands for future release	19
8.1	Low-band spectrum	21
8.2	Mid-band spectrum	23
8.3	High-band spectrum	32
8.4	Other frequency bands	40
8.5.	Priority and timing of spectrum releases for 2018 to 2022	41
9.	Obtaining copies	43

1. Intent



Innovation, Science and Economic Development Canada (ISED) recognizes that rapid growth of innovative technologies and services is driving the digitization and automation of every sector of the economy. In support of Canada's Innovation and Skills Plan, and with a focus on ensuring that Canadians benefit from world-class networks and advancements in new digital technologies and services, ISED acknowledges that as demand for digital connectivity grows so will the demand for spectrum. Through the release of this document (hereinafter referred to as the Spectrum Outlook), ISED, on behalf of the Minister of Innovation, Science and Economic Development, outlines its overall approach and planning activities related to the release of spectrum for commercial mobile services, licence-exempt applications, satellite services and wireless backhaul services over the years 2018 to 2022, resulting from the consultation process SLPB-006-17, *Consultation on the Spectrum Outlook 2018 to 2022* (hereinafter referred to as the Outlook Consultation).

All comments and reply comments received for the Outlook Consultation are available on ISED's website. Comments and/or reply comments were received from Bell Mobility Inc. (Bell), the British Columbia Broadband Association (BCBA), Canadian Cable Systems Alliance/Independent Telecommunications Providers Association (CCSA/ITPA), Canadian Electricity Association (CEA), Canadian Association of the Wireless Internet Service Providers (CanWISP), Cape Breton Regional Municipality, CBC/Radio-Canada (CBC), Cisco, Corridor Communications Inc. (CCI), Cogeco Communications Inc. (Cogeco), Canadian Wireless Telecommunications Association (CWTA), Decawave, Dr. Gregory Taylor, Dynamic Spectrum Alliance (DSA), Eastern Ontario Wardens' Caucus (EOWC) and Eastern Ontario Regional Network (EORN), Ericsson Canada Inc. (Ericsson), Facebook, Fire Service Association of Nova Scotia, FONTUR International (FONTUR), Global Mobile Suppliers Association (GSA), Huawei Technologies Canada Co. (Huawei Canada), Hughes Canada, Intelsat Corporation (Intelsat), Iridium Satellite Canada Ltd. (Iridium), Medtronic, Michael B. McNally, Microsoft Corporation (Microsoft), Motorola Solutions (Motorola), Municipality of the County of Cumberland, Municipality of the County of Antigonish, Municipality of the County of Colchester, Municipality of the County of Richmond, Municipality of the County of Victoria, Nokia, Qualcomm Incorporated (Qualcomm), Québecor Média Inc. (Québecor), Radio Advisory Board of Canada (RABC), Rogers Communications Canada Inc. (Rogers), Saskatchewan Telecommunications (SaskTel), Satellite Operators Coalition, Seaside Wireless Communications (Seaside Wireless), SES, Shaw Communications Inc. (Shaw), Sogetel Mobilité Inc. (Sogetel), Sprint Corporation (Sprint), Telesat Canada (Telesat), Telrad Networks (Telrad), TELUS Communications Inc. (TELUS), TeraGo Networks Inc. (TeraGo), TerreStar Solutions Inc. (TerreStar), Wi-Fi Alliance and Xplornet Communications Inc. (Xplornet).

2. Policy objectives



The radio frequency spectrum is a unique, finite resource that is an integral component of Canada's telecommunications infrastructure. It provides access to a broad range of private, commercial, consumer, defence, national security, scientific and public safety applications and services that benefit all Canadians. The Minister of Innovation, Science and Economic Development, through the *Department of Industry Act*, the *Radiocommunication Act* and the *Radiocommunication Regulations*, with due regard to the objectives of the *Telecommunications Act*, is responsible for spectrum management in

Canada. As such, the Minister is responsible for developing goals and national policies for spectrum utilization and for ensuring the effective management of the radio frequency spectrum resource.

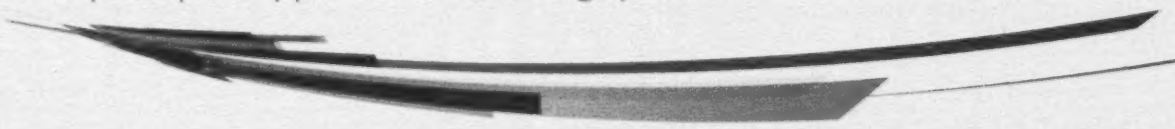
ISED is committed to delivering on Canada's Innovation and Skills Plan by ensuring that Canada has a world-class telecommunications infrastructure and that Canadian consumers, businesses and public institutions continue to benefit from advanced wireless telecommunications services and applications. A robust wireless telecommunications industry drives the adoption and use of digital technologies and enhances the productivity and competitiveness of the Canadian digital economy. ISED is focused on the three pillars that matter to Canadian families and businesses:

- Quality: faster and higher quality networks to do what Canadians need them to do
- Coverage: better coverage and reliable services available to Canadians no matter where they live and work
- Prices: affordable prices and more choice in services

Wireless technologies play an essential role in almost all aspects of contemporary life – they are reshaping the way people live and work. With the rapid and ongoing pace of advancement in these technologies, ISED's challenge is to prepare for the future while continuing to support the services that Canadians depend on today. In the near term, 5th generation (5G) technology is expected to support the expansion of new wireless applications into vertical market segments including agriculture, manufacturing, healthcare, public safety and transport, which will help foster growth and competition in the Canadian economy. According to the GSMA report *The Mobile Economy 2018*, early 5G commercial launches are expected in 2019 and 2020. The first wave of 5G deployments will focus on achieving much higher data rates, improved connectivity and higher system capacity compared to existing 4G networks. Additional advanced 5G features, such as ultra-reliable low latency, massive machine-to-machine communication and network slicing, are expected to start to be deployed commercially in late 2020 or early 2021 once the standards are completed in late 2019. These advanced 5G features will be used by industries in the vertical markets. ISED expects that the availability of equipment for these 5G vertical markets is demand driven and will be determined in part by the business cases and investment plans that are still maturing. In its report, GSMA forecasted that 49% of mobile connections in North America will be 5G by 2025. This level of connectivity will require a mix of services and spectrum to reach its full potential: mobile and fixed wireless access (FWA) to connect consumers and machines, backhaul and satellite to provide connectivity to the Internet, and licence-exempt applications to provide extra capacity and the support the Internet of Things (IoT). That is why ISED is planning to release a variety of low, mid and high band spectrum over the next several years, ensuring that the right spectrum is available at the right time to support services that will benefit Canadians. All Canadians should benefit from the continued evolution of wireless communications within an innovative and competitive market. To that end, in addition to the release of spectrum, ISED is planning to review some elements of its licensing regime and technical rules to facilitate the introduction of these new technologies and applications going forward.

This Spectrum Outlook supports the development of and investment in Canada's digital economy and the objectives of the Innovation and Skills Plan by providing stakeholders with a transparent and predictable roadmap of ISED's approach to ensuring that appropriate spectrum resources are available to meet future demand.

3. A principled approach to releasing spectrum



In developing policies and licensing frameworks to make additional spectrum available, the Minister is guided by the policy objectives of the *Telecommunications Act*, and the *Spectrum Policy Framework for Canada (SPFC)*, which seeks to maximize the economic and social benefits that Canadians derive from the use of the radio frequency spectrum resource. These

objectives, and the enabling guidelines listed in the SPFC, continue to be relevant for guiding the Minister in delivering their mandate of spectrum management.

Spectrum is a critical resource for the telecommunications industry and for providing a variety of services to Canadians. ISED recognizes the importance of relying on market forces in spectrum management, to the maximum extent feasible. However, there will also be a need to make spectrum available for a range of services that are in the public interest, but may not be driven by market forces. In particular, spectrum will continue to be made available to meet requirements for sovereignty, security and public safety. ISED also recognizes the impact of market conditions and competition, and will consider these issues in developing its approach to spectrum management.

Key elements to consider when releasing spectrum include the timeliness of spectrum releases to ensure they are aligned with and reflective of trends in spectrum usage, demand and technology, maximizing the use of spectrum, and fostering innovation.

In order to support the efficient functioning of markets, and to be responsive to changing technology and marketplace demands, spectrum should be made available in Canada to keep pace with international markets and global technology development. Releasing the right spectrum at the right time, in particular when there is an expected radio equipment ecosystem or when it is clear that there will be global standards, allows Canadians to benefit from access to next generation smartphones and devices that are competitively priced due to the economies of scale that are realized when manufacturers make equipment for many markets.

Wireless technology and networks continue to evolve to provide better services and more sophisticated applications across all sectors. Therefore, in support of the Innovation and Skills Plan, the long-term evolution of high-quality services and technologies should be taken into account when releasing additional spectrum.

Furthermore, the process for making spectrum available should be open, transparent and reasoned to promote predictability and therefore business and investment certainty for stakeholders. As such, ISED, on behalf of the Minister, has and will continue to conduct public consultations when making changes to spectrum allocations or when releasing additional spectrum. These consultations offer stakeholders, including service providers, manufacturers, interest groups and Canadians, an opportunity to provide valuable input into the regulatory process. Consultations allow ISED to take into consideration the views and perspectives of different stakeholders, and to validate its assumptions and information on the state of the industry, in its decision-making process.

As the spectrum resource is in limited supply, ISED seeks to maximize the use of the spectrum. As demand for spectrum increases, traditional services are competing with new services to use the same spectrum. Today, ISED often chooses to move existing services to another band to free up spectrum for new uses. In the future, this approach will not always be possible given the extent to which spectrum is already being used. However, new technologies and techniques (e.g. cognitive radio, dynamic spectrum access, smart antennas, and radio resource management techniques) are being developed that will change the way spectrum is accessed through intelligent decision-making solutions and geographic/operational awareness of the radio environment. These technologies and techniques provide new opportunities for optimizing the use of spectrum and promise to make it increasingly feasible to share spectrum between multiple different services. ISED will take into account new approaches and the impact of new technology when assessing the potential changes to spectrum allocations and when prioritizing spectrum releases.

4. Scope



The purpose of this Spectrum Outlook is to provide stakeholders with an overview of ISED's overall approach and planned activities related to meeting the expected demand for commercial mobile services, licence-exempt applications, satellite services and wireless backhaul services over the next five years. It outlines ISED's plans to address issues related to access to spectrum and enabling new technologies, and to make resources available to support telecommunications services and applications that are expected to require new or additional spectrum in the coming years.

The Spectrum Outlook is intended to reflect ISED's current direction and efforts to provide additional necessary spectrum for commercial mobile services, licence-exempt applications, satellite services and backhaul applications. As such, it may be updated from time to time in order to reflect changing priorities, significant technological changes or international developments.

When making changes to spectrum allocations or releasing additional spectrum, ISED has held and will continue to hold public consultations. In their submissions as part of the Outlook Consultation process, many stakeholders expressed views pertaining to the policy and licensing frameworks for potential future spectrum releases. These comments may be discussed in general terms in this Spectrum Outlook; however, ISED will have separate and comprehensive consultations before making any specific decisions with respect to any changes to the use of the frequency bands discussed in this document. Stakeholders are encouraged to participate in those consultations.

ISED regularly monitors trends, both within Canada and internationally, in spectrum usage and demand, technology, and markets in order to make decisions regarding the release of additional spectrum, or the reallocation of spectrum to new uses. In the Outlook Consultation, ISED discussed its assessments of these trends, and sought comments and other information from stakeholders to better inform the planning of future activities and priorities. ISED has taken into consideration submissions from stakeholders, as well as other developments since the publication of the Outlook Consultation, to produce the updated assessments that contribute to the approach outlined in this Spectrum Outlook.

Sections 1 through 4 outline the intent, policy objectives, principles for spectrum release, and scope of this Spectrum Outlook. Section 5 addresses issues related to licensing and access to spectrum. Section 6 provides a summary of the discussion regarding the expected demand for all services and presents ISED's objectives for each service or application. Section 7 addresses issues related to technology. Taking into account the issues, assessments, and objectives discussed previously, section 8 lays out ISED's plans for spectrum releases in the period 2018-2022.

5. Licensing



As the spectrum resource is in limited supply, ISED seeks to maximize the efficiency of spectrum use. As demand for spectrum increases, traditional services are competing with new services for use of the spectrum. Today, ISED often moves existing services to another band to free up spectrum for other uses. In the future, this approach will be increasingly complex given the extent to which spectrum is already being used.

ISED sought comments on future changes it should examine regarding the existing licensing regime to better plan for innovative new technologies and applications that offer benefits such as improved spectrum efficiency. Comments focused on three broad areas of the licensing regime including:

- a. ensuring that the benefits of planned spectrum releases extend to both rural and urban communities, including the provision of access to spectrum for regional carriers;
- b. reviewing the effectiveness of the regulatory regime as it relates to antenna siting and tower sharing, particularly for 5G services; and
- c. considering a mix of licensing approaches for emerging 5G applications and services.

5.1 Facilitating services for rural and remote communities

ISED's policy objective in managing spectrum is to maximize the economic and social benefits that Canadians derive from the use of the radio frequency spectrum, including rural and remote regions. In pursuing its policy objective, ISED is committed to ensuring that Canadian consumers, businesses and public institutions continue to benefit from access to high quality wireless networks at competitive prices in urban as well as rural and remote communities. Wireless technology, whether through fixed or satellite broadband, is a key component of connectivity for rural homes and businesses, particularly in areas where wireline solutions are not feasible. ISED works to ensure that spectrum resources are available for the various services that offer broadband connectivity to rural Canadians. A number of comments to the Outlook Consultation highlighted the challenges involved in enabling connectivity for Canadians and businesses in rural and remote communities.

Summary of comments

Several comments, such as those of Xplornet, Seaside Wireless, CanWISP, BCBA, EOWC/EORN, the Fire Service Association of Nova Scotia, the Cape Breton Regional Municipality, the Municipality of Cumberland and the municipalities of the counties of Antigonish, Colchester, Richmond and Victoria, underlined the need for spectrum to support rural broadband services, particularly for FWA services.

BCBA, Michael McNally, SaskTel, Seaside Wireless, Dr. Gregory Taylor and Xplornet encouraged ISED to examine licensing approaches and policies to improve coverage, and ensure the benefits of 5G technologies are made available to Canadians in rural areas, in addition to suburban and urban areas. BCBA, CanWISP and Xplornet, for example, recommended considering different licensing approaches for rural and urban areas, for example, auctions in urban areas and light licensing in rural areas. EOWC/EORN and Xplornet suggested that licence areas be divided to ensure that rural and urban areas are separate. BCBA, CCSA/ITPA, CanWISP, Cogeco, Seaside Wireless and Sogetel encouraged ISED to use smaller licence areas.

Additional comments focused on the need to make spectrum available to regional carriers interested in providing service in rural or remote areas. For example, CanWISP, Cogeco and EOWC/EORN supported the use of pro-competitive measures such as spectrum set-asides and aggregation limits. Additional comments addressing the availability of spectrum for rural and remote service focused on deployment. CCI and EOWC/EORN advocated for accelerated and higher deployment conditions, noting that ISED's population-based spectrum licence deployment conditions lead carriers to deploy first to urban areas and then, if at all, to less-populated rural areas. CanWISP, Seaside Wireless and Xplornet focused on the need for ISED to monitor deployment conditions and require licensees to provide information on their provision of service and compliance with deployment conditions. Some comments discussed the use of subordinate licensing to make spectrum available to regional carriers. For example, CCI, CCSA, Cogeco, EOWC/EORN, Seaside Wireless and Xplornet encouraged ISED to adopt a "use it or lose it" approach to require licensees that have not deployed to subordinate their spectrum. Michael McNally suggested that ISED consider the extension of RP-019, *Policy for the Provision of Cellular Services by New Parties* to other bands. Cogeco suggested that ISED should develop policies to facilitate reassignment of spectrum, which

has been licensed but not used, for example through subordination at pre-determined tariffs or through reassignment. CanWISP suggested an arbitration process be available to deal with subordinate licensing negotiations.

Discussion

ISED's approach to spectrum licensing has included various measures to encourage wireless coverage to rural and remote regions. A number of recent and upcoming spectrum decisions such as SLPB-001-18, *Spectrum Licence Renewal Process for Advanced Wireless Services (AWS-1) and Other Spectrum in the 2 GHz Range* and SLPB-002-18, *Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band* place an emphasis on promoting rural connectivity through deployment requirements that go beyond the major urban areas.

Another element of ISED's approach to encouraging wireless coverage to rural and remote areas is making spectrum available at a lower cost. This includes providing additional spectrum for licence-exempt use such as white space devices. ISED also notes the benefits of licensing spectrum on a shared basis (e.g. all-come, all-served such as wireless broadband service (WBS) in 3650 MHz), which allows access to spectrum for all entities, including small providers, non-profit providers, and new providers that may be interested in a low-cost spectrum option for broadband deployment in rural and remote areas.

With the anticipated increased demand for spectrum for the variety of uses described in the Outlook Consultation, and the growing importance of wireless services for Canadians in all regions, ISED will develop licensing policies giving consideration to encouraging service provision in rural areas to ensure that Canadians in all areas of the country benefit from the latest technologies including 5G. These policies will be developed in a transparent manner through consultation.

5.2 Antenna sites and structures

Small cell antennas are being incorporated into mobile networks to provide the increased capacity and coverage required to meet the expected increase in demand for data. These antennas are currently being deployed in Canada to support 4G services, particularly in densely populated areas. The deployment of small cell antennas is expected to accelerate to support new 5G features and the associated increase in demand for data. Deployment will be significant, with estimates that the number of small cells will be ten to one hundred times greater than existing commercial mobile antennas or macro cells.

ISED facilitates arrangements between carriers and municipalities regarding antenna siting and promotes the efficient and effective use of tower and antenna sites as set out in CPC-2-0-03, *Radiocommunication and Broadcasting Antenna Systems*, which balances the need for carriers to consider local impacts while ensuring that carriers are able to deploy antenna systems required in order to provide services to Canadians. In addition, through its CPC-2-0-17, *Conditions of Licence for Mandatory Roaming and Antenna Tower and Site Sharing and to Prohibit Exclusive Site Arrangements*, ISED facilitates access to existing towers by requiring that carriers share antenna towers and sites that they own and not enter into exclusive site arrangements.

Summary of comments

Comments on this matter all expressed concern that negotiating and managing access to potentially thousands of sites, owned by municipal government, utility companies or other owners, could impede the large-scale deployment of small cell antennas. Ericsson urged ISED to revise its current regulations and devise a strategy to facilitate small cell deployment, whereas CWTA, Québecor and Rogers recommended that ISED develop a national framework of best practices to facilitate small cell deployment. Québecor, Shaw and TELUS were concerned about the administrative burden on carriers needing to access municipal infrastructure, and encouraged ISED to develop policies to streamline this process. Bell recommended that ISED institute exclusions to its tower-siting procedures for small cells. Comments from EOWC/EORN, Rogers and Shaw

suggested a need for ISED to further facilitate access to antenna support structures owned by other entities, particularly certain telecommunications companies and hydro utilities.

Discussion

ISED notes the concerns raised by numerous stakeholders regarding the procedural and administrative requirements of its current antenna structure and siting framework. Furthermore, ISED recognizes that there is a need to support the timely deployment of the large number of small cells that are required to provide ubiquitous high capacity coverage of 5G systems. ISED will assess the antenna structure and siting policies within its purview and consult, if required, on any proposed changes to ensure its regulatory regime remains effective in the context of the wide deployment of small cell antennas for 5G.

5.3 Licensing approaches for 5G services

5G represents the next major advancement in mobile telecommunications standards, enabling much higher data rates, massive machine-to-machine communication, and ultra-reliable low latency communications such as those for emerging IoT applications. 5G is expected to require a combination of licensed and licence-exempt spectrum to support both commercial mobile and IoT devices. In addition, ISED recognizes that more flexible use licensing will allow for a combination of FWA, mobile and backhaul components to be deployed as part of 5G networks.

Summary of comments

A number of comments addressed the need for spectrum to be made available, in a variety of ways, for 5G services and IoT. Ericsson and the RABC recommended that more spectrum be made available on a licensed basis for such uses. Huawei Canada further suggested that certain critical IoT services such as autonomous vehicles, factory automation or hospital medical devices be assigned specific licensed spectrum bands. Other comments focused on the need for licence-exempt spectrum to support IoT in rural areas, for example, EOWC/EORN posited that agricultural IoT and autonomous farm vehicles would require access to licence-exempt spectrum. New categories of spectrum users are also likely to emerge, and Cisco and FONTUR noted that private networks and enterprise users would require bands of licensed spectrum, available in suitably sized geographic footprints, to support 5G applications and IoT. Comments from Bell, Sogetel, TELUS and the Wi-Fi Alliance noted that 5G and IoT applications would require larger spectrum blocks (and, as TELUS observed, more contiguous spectrum blocks). EOWC/EORN expressed concern that the allocation of spectrum in larger blocks would favour major carriers and increase the potential for spectrum to go unused. Bell, BCBA, Cogeco, CCI, EOWC/EORN, Ericsson, Facebook, Huawei Canada, Québecor, Rogers, SaskTel, Shaw, TELUS, and Xplornet supported the concept of flexible use licensing as a means to maximize spectral efficiency and allow operators to provide different types of services (e.g. FWA and mobile) using the same spectrum.

Discussion

ISED notes the comments that were made with respect to the need to support innovative 5G services and the development of IoT applications in a way that encourages investment, is minimally restrictive (e.g. flexible use) and facilitates provision of these services. ISED will take into consideration technology and spectrum management developments when consulting on spectrum releases with a view to ensuring that Canadians continue to benefit from the most advanced technology and services.

6. Demand

6.1 Overall demand for data

The demand for radio frequency spectrum continues to rise as a result of growth in wireless broadband users, devices and innovative applications. According to the *Cisco Visual Networking Index (Cisco VNI)*,¹ by 2021 the number of devices and connections is expected to be three and a half times the world population, compared to just over twice the world population in 2016. Annual global Internet protocol (IP) traffic is expected to reach 3.3 Zettabytes (ZB) by 2021, up from 1.2ZB in 2016. Cisco also indicated that the proportion of global IP traffic from Wi-Fi and mobile devices will increase from 48% in 2016 to 63% by 2021. It is also expected that service providers will face increased pressure to meet the demand for access to high-speed, bandwidth-intensive services and applications (e.g. video and music streaming), with Cisco forecasting that, globally, average per capita monthly traffic will increase to 35.5 Gigabytes (GB) by 2021, up from 12.9 GB per capita in 2016. According to the *Ericsson Mobility Report*, North America monthly mobile data traffic per smartphone is expected to reach 48 GB by the end of 2023.

This overall demand for data is expected to impact the spectrum requirements for services or applications that provide wireless data services. In the Outlook Consultation, ISED mentioned that the volume of data to be carried over various networks is expected to increase between three- and six-fold by 2020 and that the most significant growth in demand for data will be for commercial mobile services, licence-exempt applications (largely Wi-Fi), satellite services and backhaul. Therefore, ISED has focused on these four services and applications in considering future spectrum releases from 2018 to 2022.

ISED recognizes that there are several variables that impact spectrum requirements (e.g. technology, traffic growth, network design), and that these can vary significantly for different networks, applications and services. Furthermore, traffic growth for some services and applications can impact the spectrum requirements of other services (e.g. demand for commercial mobile traffic can impact the demand for backhaul spectrum and due to commercial mobile off-loading, can impact the demand for licence-exempt spectrum). Therefore, ISED sought comments regarding spectrum demand in Canada and the global and domestic technical or operational advancements and market trends that will impact the demand for spectrum over the next five years.

In the comments received, there was general agreement that technological developments will assist in addressing traffic demand and capacity needs for commercial mobile, licence-exempt, satellite and backhaul operations. However, there was also general agreement that additional spectrum will be required in the future given the expected growth in usage and demand for data-intensive services. The section below provides more detail regarding the demand for each of the four services separately.

¹ The Cisco Visual Networking Index (VNI) is a collection of reports and forecasts, updated annually, regarding global fixed/mobile traffic and Internet trends.

6.2 Commercial mobile services

The evolution of mobile communications has had a significant impact on all sectors of the economy and continues to contribute to the economic and social well-being of Canadians. Canadians want high-quality services, ubiquitous coverage and affordable prices from their telecommunication service providers. Smartphones, tablets, wearable devices, machine-to-machine (M2M) devices and the applications that run on them are changing the way that Canadians work, live and play. Mobile communications have become integrated into the daily lives of Canadians as they increasingly rely on mobile services to access a variety of applications, such as multi-media services, social networking and Internet browsing, on a day-to-day basis to do business, connect with others, and to manage finances, health and homes.

Commercial mobile spectrum requirements depend on the total amount of traffic and the number of subscribers accessing the network at peak periods, as well as the network design. In addition, commercial mobile networks are often made up of a mix of technologies (e.g. high speed packet access, LTE and in the near future 5G), which have different spectral efficiency in terms of the amount of traffic they can carry over a particular bandwidth. In the future, the response to additional traffic demands is expected to be more challenging, due to the use of more bandwidth-intensive applications and innovative uses for mobile spectrum. ISSED considered three factors to assess the future spectrum requirements for commercial mobile services: subscribership, traffic growth and technology advancements.

In the Outlook Consultation, ISSED's assessment was that, based on a number of studies, all regions and markets are expected to continue to experience growth in mobile subscribership. It also concluded that as subscribership continues to increase in all regions, so will global monthly traffic. ISSED recognized that the continued growth in data traffic generated by an increasing number of users in various sectors and the data-intensive applications running on mobile networks may not be sustainable with the use of existing mobile spectrum alone. ISSED further concluded that the new applications and services that are expected to be made available through 5G technologies will likely require spectrum in different frequency ranges.

Summary of comments

Stakeholders generally agreed with ISSED's assessment that Canada will experience a substantial increase in demand for commercial mobile services. More specifically, Bell, CanWISP, Cisco, CCI, Cogeco, CWTA, DSA, Ericsson, GSA, Québecor, RABC, Rogers, SaskTel, Seaside Wireless, Sogetel, Telrad, TELUS and TeraGo agreed with ISSED's assessment.

Some stakeholders commented that, if anything, ISSED may be underestimating demand. Rogers stated that it believes the actual growth in demand for mobile spectrum far exceeds ISSED's current and planned future spectrum releases and that the growth is exponential, which makes conventional approaches to capacity planning impractical. Shaw mentioned that, based on its own projections, the demand assessments in the Outlook Consultation may underestimate future demand. TELUS was of the view that ISSED must proactively plan to address demand beyond the forecasts provided by Cisco's VNI and other studies by allocating spectrum for all 5G use cases to ensure that networks are able to address the demand created by unforeseen applications that will accompany Canada's 5G future. GSA mentioned that the combination of the capability of a 5G network with the expected reduction in the cost of devices is expected to lead to ubiquitous connectivity. It further mentioned that analysts estimate that 44 zettabytes of data will be generated by 2020 and 180 zettabytes by 2025.

With respect to the demand drivers identified by ISSED in the Outlook Consultation, some stakeholders advanced other commercial mobile demand drivers, while others emphasized the importance of particular drivers in their comments. Telrad agreed in general with ISSED's assessment in the Outlook Consultation, but mentioned that they would agree completely with the assessment if ISSED considers FWA as a component of mobile due to fixed and mobile convergence. Xplornet acknowledged that demand for mobile bandwidth is increasing, but cautioned ISSED not to focus on mobile to the exclusion of fixed, because as mobile traffic grows, so does fixed traffic. Bell mentioned fixed wireless internet connectivity and High Definition/4K video as demand drivers while Ericsson, RABC and Shaw mentioned that new technologies such as

Augmented Reality and/or Virtual Reality will drive demand and put pressure on existing spectrum. Rogers stated that it believes vehicle-to-everything (V2X) services are going to drive additional demand for spectrum going forward.

Discussion

Mobile operators have several options available to optimize the use of their spectrum holdings to meet increased traffic demand, such as densifying their networks, deploying efficient equipment and employing more sophisticated traffic management techniques. However, ISED recognizes that the continued growth in data traffic generated by an increasing number of users and expected new uses (e.g. augmented and virtual reality and V2X) in various sectors and the data-intensive applications running on mobile networks may not be sustainable with the use of existing commercial mobile spectrum only. As such, ISED intends to release additional spectrum for commercial mobile in the next five years.

Mobile technology is constantly evolving to make more efficient use of spectrum in order to meet the increasing traffic demands. However, some technology advancements require new spectrum for reasons other than increased demand. For example, some specific bands may be required due to their ability to accommodate large bandwidths or due to their specific propagation characteristics. In particular, the new applications and services that are expected to be made available through 5G technologies will likely need bands in different frequency ranges in order to be realized. 5G networks will require low-range frequency bands for coverage, mid-range frequency bands to provide both coverage and capacity, and high-range frequency bands to provide large bandwidths to meet high broadband speeds. When considering spectrum releases for commercial mobile services ISED will also take into account these different frequency ranges needed for the deployment of 5G networks.

ISED also recognizes that 5G is envisioned to provide a variety of types of services beyond just mobile connectivity, such as FWA to provide Internet to the home and business and machine-to-machine communications.

6.3 Licence-exempt

Over the past number of decades, licence-exempt spectrum has witnessed a significant increase in use and innovation due to the low barriers to entry, such as easy access to spectrum and the low cost of devices. Consumer devices that use licence-exempt spectrum appeared in the 1980s, for example, baby monitors and garage door openers, and have now expanded to include mobile devices such as smart speakers, health trackers, and remote control drones. In the context of the Outlook Consultation, discussion on 'licence-exempt' was focused mainly on Wi-Fi and IoT applications (e.g. connected wearable devices, connected cars and cities), as these have seen the most significant growth in recent years. However, ISED recognizes that new technologies are emerging, such as LTE-unlicensed (LTE-U) and LTE-Licensed Assisted Access (LTE-LAA), which can also be enabled through the use of licence-exempt spectrum. Today, licence-exempt spectrum is a critical part of mobile connectivity as it provides Canadians an additional method of accessing voice and data communication services on their handheld and other wireless communication devices.

The IoT industry is relatively nascent but is quickly growing. The majority of IoT devices are expected to use licence-exempt spectrum to communicate with computers, smartphones and tablets, as well as to communicate amongst themselves (e.g. M2M). These devices are primarily used for monitoring healthcare, industrial applications, automotive, tracking utility consumption and for safety and security. However, it is expected that many new applications and opportunities will appear in the future.

In the Outlook Consultation, ISED examined the expected demand for Wi-Fi and IoT separately. ISED concluded that there will be a growing demand for spectrum in the licence-exempt bands, largely due to the growth of Wi-Fi devices seeking higher speeds and performance, and the potential volume of IoT devices. Technology advancements are expected that will allow some of the traffic demands to be met by making the use of spectrum more efficient. However, ISED recognized that

the expected growth in the number of devices will put pressure on the existing licence-exempt bands in the next five years, and that there may be a requirement for additional spectrum to fully meet expected demand.

Summary of comments

Stakeholders generally agreed with ISED's assessment that there will be a growing demand for spectrum in the licence-exempt bands. More specifically, BCBA, CEA, CanWISP, Cisco, CCI, Cogeco, CWTA, Dr. Gregory Taylor, DSA, EOWC and EORN, Facebook, FONTUR, Microsoft, Québecor, SaskTel, Seaside Wireless, Shaw, Telrad and Wi-Fi Alliance agreed with ISED's assessment.

Some stakeholders provided further information regarding licence-exempt demand. Cisco projects that the amount of traffic offloaded from smartphones will be 78% by 2021, compared to 69% at the end of 2016 and that of all IP traffic (fixed and mobile) in Canada, 55% will be Wi-Fi, while only 38% will be wired, and 7% will be mobile. Cisco also mentioned that M2M modules will account for 67% (271.4 million) of all networked devices in 2021, compared to 50% (115.5 million) in 2016. Wi-Fi Alliance conducted its own *Wi-Fi Spectrum Needs Study* showing that, based on traffic predictions for a number of countries around the world, between 500 MHz and 1.8 GHz of new spectrum would be needed for Wi-Fi operations in order to avoid a looming spectrum shortage. This study was also mentioned by Microsoft, Rogers and DSA. Shaw and Cisco mentioned other studies showing that additional spectrum will be needed for licence-exempt applications.

A number of comments were received emphasizing the need for additional licence-exempt spectrum. FONTUR, CanWISP, Cisco and Wi-Fi Alliance mentioned the need for more licence-exempt spectrum as Wi-Fi bands become saturated. Wi-Fi Alliance was of the view that ISED should move quickly to make additional spectrum available to meet this growing demand. Facebook mentioned that ensuring that sufficient licence-exempt spectrum is available will be critical for the growth of 5G as well as supporting existing, growing demand for Wi-Fi. Xplornet mentioned that while true that there will be more devices connected using Wi-Fi, it is not convinced that significant amounts of new spectrum will be required. It mentioned that most devices are short-range, allowing for reuse of spectrum and that IoT devices will utilize little bandwidth compared to most broadband applications and concluded that while the number of such devices is expected to grow exponentially, actual bandwidth requirements will not be a major factor in the next five years. The RABC mentioned that simply providing additional licence-exempt spectrum will not meet quality-of-service needs for all applications and should be seen as a complement to licensed spectrum, a position supported by Ericsson. CanWISP disagreed with this statement in its reply submission. TELUS agreed with ISED's relative growth projections of Wi-Fi data usage but asserted that the relative growth of commercial mobile data usage is higher still. TELUS further mentioned that licence-exempt spectrum may experience congestion at some point in the future, but licensed commercial mobile spectrum will experience congestion before 2022 and with potentially significant impact to the digital economy.

In addition to Wi-Fi and IoT, some stakeholders identified other drivers of licence-exempt demand, or emphasized the importance of particular drivers. CCI noted that a major demand driver will be the augmentation of existing contention-based protocols (i.e. LTE and 5G), rather than the proliferation of IoT and Wi-Fi usage cases. Microsoft also provided a broader set of use cases that it expects will drive the demand for licence-exempt spectrum such as: wireless docking, 4K video streaming, next generation gaming, 'wireless fibre' connections inside data centres or between optical fibre strung along utility poles and one or more structures, multiple users of augmented reality devices in relative proximity in factories, warehouses and retail spaces, and mobile robots that utilise machine vision and telemetry as inputs to cloud-based artificial intelligence. EOWC and EORN mentioned increased automation and product tracking in agriculture—from monitoring environmental conditions in vineyards, animal tracking, and autonomous farm vehicles—will drive the demand for spectrum in their region. Huawei Canada identified factory automation, traffic control, wearables, smarter homes, enterprise applications, home control, gaming and machine IoT type communications services as areas of traffic growth. CEA reinforced the growing need for licence-exempt spectrum for the industrial IoT, in particular for Canadian Electric Utilities, and RABC supported this view in their comments.

Bell mentioned that they believe licence-exempt spectrum will continue to be utilized for offloading and to improve end-user throughput, especially LTE-U or LAA is employed. Bell also mentioned that licence-exempt channels in frequency ranges below 6 GHz should only be allocated on an exceptional basis in the bands that will not be required for licensed use. CanWISP disagreed with that statement in its reply comments, mentioning that if ISED were to give priority only to licensed spectrum, large mobile service providers could easily outbid other bidders and consequently, WISPs would not be able to access additional spectrum at a reasonable cost. CEA noted that commercial communication service providers are increasingly using licence-exempt spectrum to add to their networks, for example through voice over Wi-Fi integration and LTE-LAA technology. TELUS mentioned that LTE-LAA radio technology in licence-exempt bands has begun to make its way into smartphones as another means of connectivity that may impact Wi-Fi hotspot use.

Discussion

Wireless communications have become essential for the digital economy, and the use of licence-exempt spectrum plays a critical role in enabling this connectivity. ISED has and will continue to facilitate the introduction of technologies such as Wi-Fi, LTE-U, LTE-LAA and IoT. These technologies operate on multiple frequency bands using various communication protocols, are increasingly smarter and more cognizant of their operating environment, and implement the latest spectrum sharing and interference mitigation techniques. It is expected that the industry will continue to develop technology to function more effectively in unlicensed bands.

In recognising the importance of the licence-exempt ecosystem and the opportunities that it enables, ISED will continue to update its technical equipment standards to keep pace with the latest technological developments. Over the next five years, ISED will amend its standards in a timely fashion to reflect the latest advancements in these technologies, which are anticipated to alleviate some of the traffic demand by making more efficient use of spectrum. Moreover, ISED may amend existing technical standards to address outcomes of the World Radiocommunication Conference in 2019 (WRC-19). ISED may also create new technical equipment standards to support the entry of new innovative products in Canada. Compliance with ISED's technical standards is crucial to ensure that wireless devices in Canada are safe and support a competitive wireless market. Consequently, ISED will apply timely and effective enforcement measures when devices are found to be non-compliant with equipment standards.

ISED recognizes that technology advancement alone cannot fully support the growth of licence-exempt devices, such as Wi-Fi and IoT devices. In the next five years, ISED will seek to identify opportunities to release additional bands for licence-exempt use in order to address demands.

6.4 Satellite

Due to Canada's vast land mass and widely dispersed population, satellite systems play a vital role in providing communications capabilities in rural, remote and northern communities, where terrestrial facilities are limited or non-existent. In these communities, satellite systems provide the backbone for, or direct access to, essential services such as basic telephone, broadcasting and Internet services.

In urban areas, satellite systems are used to provide direct-to-home television services to consumers and underpin Canada's broadcasting system by transferring content from creators into the cable distribution system. In both urban and rural areas, satellite services also play a critical role in times of emergency, such as natural disasters, when terrestrial telecommunications infrastructure may be disabled. Satellite systems are also used extensively by government to support national security and to assist in monitoring the environment.

As mentioned in the Outlook Consultation, globally it is expected that demand for satellite capacity will continue to grow over the next five years, particularly in higher frequency bands, due to demand for more bandwidth and ubiquitous connectivity. Consumers and businesses expect to be connected anywhere, anytime, including in areas that are beyond the reach of terrestrial networks. Increased government use (i.e. high resolution imaging, new constellations of global navigation satellites, defence, etc.) is also expected to affect demand. The Outlook Consultation also mentioned that the main drivers for the expected satellite capacity demand growth are broadband applications, such as access to the Internet and over-the-top video distribution, potential deployment of new non-geostationary satellite orbit (NGSO) satellites providing connection speeds that could be comparable to terrestrial systems, and the expanding commercial earth observation market (i.e. mapping, climate monitoring and natural resource exploration). However, growth in North America is expected to be lower in comparison to developing countries, as satellite services are more mature and penetration of terrestrial infrastructure is much higher. Given the broad array of satellite applications, users, bands, services, and technologies, the Outlook Consultation concluded that a general global growth projection for satellite spectrum would not give a clear indication of demand in Canada. Therefore, ISED examined the demand for satellite services based on different types of services, fixed satellite service (FSS), broadcast satellite service (BSS), mobile satellite service (MSS) and earth observation satellite applications separately. Furthermore, for FSS and BSS the Outlook Consultation examined the demand for C-band (3.5 GHz-7 GHz), Ku-band (10 GHz-18 GHz) and Ka-band (18 GHz-30 GHz). Other satellite services, such as amateur-satellite service, space research, inter-satellite service, radionavigation satellite services and aeronautical satellite services were not included in the consultation as they are not expected to be directly impacted by increased demand for data.

Based on its examination of demand projections and technical advances for satellite systems, ISED observed an overall trend towards moving to higher frequencies to better accommodate data-intensive applications that require larger bandwidths (i.e. higher capacity Internet services and high resolution images and video). Based on this expected demand, ISED indicated in the Outlook Consultation that it believes that it would be possible to consider how C-band could be used in the future. For FSS and BSS, the demand for bandwidth-intensive applications, congestion in the Ku-band, demand for Ka-band and the emergence of NGSO systems all led ISED to believe that there will be a need to consider additional spectrum for these types of satellite services. ISED also indicated that earth observation systems require the consideration of additional spectrum. For MSS, the Outlook Consultation concluded that, although there is expected growth for these services in the next five years, the existing MSS spectrum is likely sufficient to meet this demand.

Summary of comments

With respect to satellite services demand, the responses received were mixed. Some respondents such as Bell, CCI, Hughes Canada, SaskTel and Xplornet agreed with ISED's assessment of demand. Satellite operators and the RABC generally agreed with the assessment of increasing demand for satellite services and spectrum, noting the importance of the C-Band and recognizing growing use in both Ku and Ka-bands, and higher bands. Rogers held that the demand for satellite services, especially outside of rural and remote locations, was overstated.

With regards to the demand for FSS and BSS, Intelsat, RABC, SES and Telesat discussed the significant growth in demand for connectivity and ubiquitous data services, as well as new and expanding applications (e.g. IoT and backhaul) expected to significantly increase demand for fixed-satellite services over the next five years.

With regards to the C-Band, CanWISP agreed with ISED's demand assessment. Some FSS operators such as Intelsat, Telesat and SES, and other respondents including CBC and RABC, disagreed with ISED's assessment that there is reduced demand for FSS in the band 3700-4200 MHz. Intelsat and Telesat argued that demand will grow in the C-Band in the next five years, whereas, CBC, RABC and SES stated that the demand would be steady. In their reply comments, Intelsat, Telesat, the Satellite Operators Coalition and SES disputed the notion that C-band demand would be steady.

For the Ku- and Ka-bands, satellite operators recognized the heavy satellite use/congestion in the Ku-band, which is expected to grow even more driven by applications such as earth-stations-in-motion (ESIM) and increased traffic growth in general. Telesat indicated that the demand for Ka-band spectrum is expected to grow rapidly in the next few years with new geostationary satellite orbit (GSO) and NGSO satellites, fueled by the growth in demand for broadband Internet and data intensive services.

In terms of technological advancements, Intelsat mentioned that the limited amount of spectrum available for satellite services means that there is a need for spectrum to be utilized efficiently. A number of commenters discussed new technologies, which may reduce the cost, increase spectrum efficiency and reuse, and increase the capacity of satellite infrastructure to deliver high-speed data services in response to demand. High-throughput satellite (HTS) was highlighted by Bell, Cogeco, Intelsat, RABC, SES, Telesat, and Xplornet. Low-Earth orbit (LEO) was discussed by Cogeco, Hughes, RABC, SaskTel, and Telesat. ESIM were mentioned by Hughes Canada, Intelsat, RABC and Telesat. RABC, SES, and Telesat highlighted advances in antenna technology. Telesat mentioned that technological advancements that are being deployed by satellite operators and their customers will not be sufficient to offset increased demand, with the result that additional satellite spectrum is required.

Intelsat also urged ISED to continue studies of ESIM systems, and to streamline and simplify earth station licensing procedures for satellite terminals in order to support new mobility and broadband applications.

More specifically, with respect to MSS demand, Bell, CCI, Cogeco, Intelsat, RABC and Xplornet agreed with ISED that although there is an expectation of global MSS growth of 8% by 2020, as indicated in the Technavio, *Global Mobile Satellite Service Market 2016-2020* report, existing MSS spectrum is likely sufficient to meet this demand in Canada. Iridium expressed concern that the Technavio report referred to by ISED did not accurately reflect the anticipated growth of MSS. Specifically, Iridium indicated that the report cited by ISED does not reflect the robust growth Iridium has experienced over the past seven years and expects to experience in the future. RABC mentioned that MSS applications have increased in the last few years due to advances in both space segment and ground segment technologies. They added that many new mobile applications will require MSS to deploy future technologies in order to move to new and/or higher frequency bands; the main demand drivers being video, environmental data and IoT related data from connecting billions of sensors, devices, machines, connected cars, etc.

Only a few comments were received regarding earth exploration satellite service (EESS) demand. CCI agreed with the demand assessment put forward by ISED and RABC noted that many EESS have been launched due to the growing user demand, as well as the technological advancements in satellite sensor and imaging design techniques. RABC recommended safeguarding the current allocated spectrum to earth observation (passive and active) and space research domestically and internationally.

Discussion

Based on its examination of current demand projections and technical advances in satellite systems, ISED expects to address the needs of these services by consulting on making additional spectrum available and improving access for satellite services.

For MSS, ISED continues to believe that existing MSS spectrum is likely sufficient to meet the demand in Canada.

For Earth observation systems, ISED notes that it recently made changes to the Canadian Table of Frequency Allocations (CTFA) to include new primary allocations to EESS in the 7 GHz (7190-7250 MHz) band to address the congestion in satellite command and control, and in the 9 GHz (9200-9300 MHz and 9900-10400 MHz) band to accommodate the higher resolution wideband synthetic aperture radars. ISED believes this new spectrum, together with existing spectrum, will likely

be sufficient for Earth observation systems over the next five years. ISED recognizes that when considering changes to allow new uses of spectrum, both in Canada and internationally, there is a need to consider the potential impact on Earth observation systems, in particular passive systems, operating in and adjacent to that spectrum.

For FSS and BSS in the C-band, ISED has observed an overall trend towards moving to higher frequencies to better accommodate data-intensive applications that require larger bandwidths (i.e. higher capacity Internet services and high resolution images and video). As a result, ISED continues to believe that it would be appropriate to further review C-band usage.

For FSS and BSS in higher frequencies, the demand for bandwidth-intensive applications, congestion in the Ku-band, the expected Ka-band demand and the emergence of new NGSO systems all lead ISED to believe that there will be a need to consider additional spectrum for these types of satellite services. ISED also recognizes the increasing trend for commercial mobile services in higher frequency bands, as mentioned in section 6.2. As such, ISED will be looking to find ways to facilitate sharing between satellite and commercial mobile services in certain frequency bands, where feasible. ISED does, however, recognize the need for dedicated spectrum for satellite services, particularly for ubiquitous deployments, and will be considering such designations in the higher frequency bands.

Recognizing the emergence of new NGSO systems that could help bridge the connectivity gap in remote and northern regions of Canada, ISED continues to take steps to address the development of these systems for broadband communications. In addition to implementing changes to its licensing framework to allow for the orderly integration of these innovative systems, ISED continues to work with other countries, both through bilateral discussions and the International Telecommunication Union (ITU), to define the bringing into use of frequency assignments, as well as establish the appropriate international implementation milestones for NGSO systems, in order to obtain and maintain the rights for international recognition and protection as appropriate. For this work, ISED endeavours to achieve a balance between adopting provisions preventing abusive practices such as spectrum reservation and recognizing the financial, technological and planning challenges posed by the obligation to proceed with the production of hundreds of satellites and the multiple launches required to complete the deployment of an NGSO constellation.

As for comments on continuing ESIM studies, ISED notes that it is currently studying ESIM internationally, in the context of identifying additional spectrum for ESIM at the ITU. These studies include work towards ensuring that existing and future services in the same bands would be protected from new ESIM use, as well as developing an international framework for ESIM, including identification of responsibilities of each country involved in licensing different segments of the same ESIM network. In addition to this international work, ISED is planning to conduct an internal review of its domestic technical and licensing frameworks for ESIM. This review is expected to begin sometime this year.

Regarding comments on the earth station licensing, ISED is currently in the process of reviewing its earth station licensing procedures and associated fee regime. This review will include the consideration of the potential for satellite terminals to support new mobility and broadband applications, as well as the increasing capacity demand for satellite services.

6.5 Backhaul

Backhaul facilities are an essential part of the infrastructure backbone that enables delivery of Internet, as well as data and voice traffic by fixed and mobile broadband networks. Backhaul is also used, for example, to interconnect remote sites and buildings for corporate, health and educational purposes and to support broadcasting undertakings in the transmission of news gathering video.

There are multiple backhaul solutions, including fibre optics, microwave radio and satellites. Generally, a combination of backhaul solutions is employed in Canada, with service providers tending to favour a mix of fibre and wireless microwave.

The selection of a particular solution is dependent on a variety of factors and considerations including technical performance, immediacy of deployment, capacity, cost, accessibility and feasibility of other options.

Backhaul facilities are an essential part of the telecommunications infrastructure, in both sparsely populated rural areas and densely populated urban areas. Wireless microwave solutions are more prevalent in remote and rural areas, whereas fibre tends to be the solution employed for high-traffic urban cell sites given its capacity and reliability. However, wireless microwave is also used for the fast deployment of small cells in metropolitan markets. Cost-effective, scalable and easy-to-deploy backhaul facilities are also vital for the introduction of microcells to complement existing cell sites. Moreover, wireless microwave solutions are used to support specific enterprise solutions.

The Outlook Consultation stated that the demand for backhaul capacity is linked to the demand for other services, including commercial mobile, licence-exempt and satellite systems that are discussed in the previous sections. While wireline backhaul solutions are expected to play a role, and new technologies such as self-backhaul could provide additional capacity, demand for other services is expected to put pressure on the spectrum currently available for backhaul facilities. In particular, the different use cases and high data rates anticipated for 5G commercial mobile services are expected to have a significant impact on the future backhaul spectrum requirements.

The Outlook Consultation further mentioned that congestion in backhaul frequency bands may continue to be experienced in some urban areas as operators expand backhaul capacity to support the demand generated by commercial mobile service. ISED believes that technical and policy changes that are currently being implemented, in conjunction with advances in backhaul technology, will serve to help operators respond to some of this demand. However, the expected capacity requirements and deployment scenarios of 5G will require that some new spectrum be made available in the next five years.

Summary of comments

Bell, BCBA, CanWISP, CCI, Cogeco, CWTA, EOWC and EORN, Québecor, Rogers, SaskTel, Seaside Wireless, Shaw, and TeraGo agreed with ISED's assessment of backhaul demand, which held that congestion may increase in the next five years as the demand for backhaul capacity is expected to grow to support the increased demand anticipated for 5G networks.

Some stakeholders supported ISED's assessment in general or in part. Ericsson supported ISED's view that the demand for backhaul capacity is linked to the demand for other services. TELUS generally agreed with ISED's assessment but mentioned that, while particular bands are facing congestion in urban and surrounding areas, TELUS forecasts that this congestion will be manageable as new radio technology becomes available and deployed before 2022. Xplornet generally agreed with ISED's assessment of demand for backhaul but noted ISED's omission of backhaul for FWA. Xplornet also indicated it sees increasing demand for FWA at faster speeds and in greater capacity as driving the demand for backhaul services.

A number of stakeholders commented on different demand drivers for backhaul. Cogeco mentioned that densification of mobile networks as a result of the introduction of 5G technologies will result in increasing demand for backhaul, as there will be more sites requiring connection to the network. The RABC expressed that demand for backhaul will be driven by the demand for greater capacity in broadband internet, mobile bandwidth, video on demand, IoT and many other services. Huawei Canada indicated that it expects that the traffic growth for backhaul in support of data communications and mobile services will mirror the growth in access traffic. Seaside Wireless indicated that the increased demand for backhaul will be due to increased broadband Internet consumption, the introduction of 5G, continued growth of other mobile services, as well as the growth of IoT devices and services. Seaside Wireless also indicated that licence-exempt and fixed wireless services, in addition to commercial mobile, are likely to generate the largest increase in demand for backhaul. Shaw generally agreed with the assessment of demand and added that one of the drivers will be the increased use of small cells in both the sub-6 GHz and millimetre wave (mmWave) bands. TeraGo indicated that, as referenced in the Cisco VNI, it is

expected that mobile video will continue to generate the most demand for backhaul capacity across all mobile networks, which in turn results in higher backhaul requirements.

Discussion

ISED recognizes that backhaul frequency bands may continue to experience congestion as operators expand backhaul capacity to support the demand for wireless services. As such, ISED has been implementing the policy changes (e.g. removing capacity restrictions) and technical changes (e.g. consider allowing larger channel bandwidths and smaller antennas) from SMSE-022-14, *Decisions on Spectrum Utilization Policies and Technical Requirements Related to Backhaul* (hereinafter referred to as the Backhaul Decision), in order to promote greater utilization of existing backhaul spectrum and increase flexibility for users to adapt to changing conditions. ISED believes that these changes and backhaul technology advances will serve to help operators respond to some of the expected additional backhaul demand.

However, ISED recognizes that the expected capacity requirements and deployment scenarios of 5G will require that some new spectrum be made available either through flexible use licensing of commercial mobile bands or new spectrum releases.

7. Technology



With the rapid growth of innovative technologies and services driving the digitization and automation in all sectors of the economy, ISED recognizes the importance of being responsive to changing technology and marketplace demands. As such, the long-term evolution of wireless technologies, networks and services should be taken into account when developing technical rules and when releasing additional spectrum. As indicated in the Outlook Consultation, ISED regularly monitors technological advancements for mobile services, licence-exempt, satellite services and backhaul given their importance in supporting the digital economy.

For commercial mobile services, the Outlook Consultation stated that ISED believes that 5G will be the next major advancement in mobile telecommunications standards, with a number of new technologies emerging or being researched as part of 5G standards development, including massive multiple input, multiple output (MIMO) technology, full-duplexing, edge computing, network slicing, and carrier aggregation techniques.

For licence-exempt applications, the Outlook Consultation mentioned the expected continued convergence and integration of commercial mobile and Wi-Fi technologies as they both evolve to meet wireless and mobile communications needs. In addition, ISED expects that industry will continue to evolve technology to function more efficiently in unlicensed bands as Wi-Fi and IoT technologies are becoming smarter and even multi-band and multi-protocol based.

With respect to developments in satellite services, ISED highlighted HTS technology, based on multiple spot beams, a high level of frequency reuse and advanced coding techniques, as one of the most significant developments. Further advances in satellite technology were discussed, including: smaller, less expensive satellites and ground station antennas, leading to the emergence of large constellations of LEO NGSO satellites designed to deliver broadband connectivity, as well as ESIM systems and advanced video compression technologies for improved resolution (e.g. 4K TV).

Finally, for backhaul, the Outlook Consultation mentioned the use of radio-link bonding to increase available capacity by combining multiple channels to simulate a single wider channel and new technologies allowing for multiband configurations

for higher capacities over longer distances by bonding large bandwidths at higher frequencies with narrow bandwidths at lower frequencies.

Summary of comments

In general, stakeholders supported ISED's assessment of key emerging technologies, with large-scale deployment for many of these expected in one to four years. A number of stakeholders, such as Bell, CanWISP, Ericsson, Quebecor, SaskTel, RABC, Rogers, Seaside Wireless, Shaw, TELUS and Xplornet also identified technologies such as LTE-U, LAA and beamforming as developing technologies that will help address traffic pressures. Huawei Canada also indicated that high-order modulation (e.g. 256 QAM), wider channel bandwidths, beam steering, better trunking efficiency and improved RF transmission technology (e.g. polar coding and filtered orthogonal frequency division multiplexing) will further improve efficiency and network capacity.

With respect to satellite developments, Telesat indicated that new technologies such as HTS, large NGSO constellations and ESIM, as well as developments in antennas, are reducing the costs and increasing the capacity of satellite infrastructure to deliver high-speed data services in response to demand.

In terms of advancements in backhaul, in addition to those discussed by ISED, stakeholders such as CCI, Qualcomm, Rogers, SaskTel, Shaw and TELUS mentioned technologies such as higher-order modulation, adaptive technologies, software defined networking, and full-duplex.

Rogers raised the need for modernization and flexibility in ISED's policies, frameworks and rules to promote innovation and investment in digital technologies. Rogers indicated that ISED plays an important role in ensuring that Canada continues to be at the forefront of 5G deployments by providing timely access to mobile spectrum, which will help capitalize on technology advancements. They added that modernization and harmonization of ISED's technical standards for bands currently available for commercial mobile services would assist in addressing traffic pressure and demand, so as to take advantage of recent developments in areas such as MIMO and beamforming antennas. Both Facebook and Rogers mentioned some specific updates to technical standards that could be made by ISED.

Regarding the concept of opportunistic spectrum access, overall comments highlighted that technological developments beyond those which are currently used to access whitespace could hold promise, while also noting that there remain technical, regulatory and business challenges to overcome in order to fully enable opportunistic spectrum sharing. In particular, Bell, CWTA, Cogeco, Québecor, SaskTel, Shaw Rogers and Xplornet, indicated that it is premature for ISED to consider implementing sharing protocols into existing commercial mobile spectrum without first completing extensive studies and full public consultations. Other stakeholders, such as DSA, Microsoft and Motorola, were in favour of dynamic spectrum sharing conceptually or within particular bands. Ericsson, Microsoft, Seaside Wireless, Shaw, Telrad and Wi-Fi Alliance also highlighted the necessity of increased spectrum sharing between services in order to support new technologies and improve access to spectrum.

Discussion

ISED is committed to promoting innovation-led growth across all sectors of the Canadian economy, including capitalizing on technology advancements to give businesses, research institutions and cities a competitive edge. As such, ISED continues to closely monitor the evolution of technology, with a view to ensuring that technical frameworks are flexible enough to facilitate the adoption and deployment of new technologies. In particular, ISED is currently exploring options to update existing technical standards to address the latest developments of MIMO. ISED is conducting an assessment of what other countries are currently doing to address MIMO from a regulatory perspective. This review will result in ISED updating relevant technical standards, which will include consultation with the RABC prior to finalization.

In order to maximize the use of the spectrum resource and make spectrum available for the variety of services and applications, ISED will continue to improve the feasibility and efficiency of spectrum sharing including sharing between different uses. Approaches include the use of mitigation techniques such as geographic separation, coordination requirements, technical rules, as well as the use of new and emerging technologies and techniques such as cognitive radio, dynamic spectrum access, data science, cloud computing, advances in spectrum monitoring, smart antennas, and other radio resource management techniques. ISED is of the view that new technologies and techniques will change the way spectrum is accessed through intelligent decision-making solutions and geographic/operational awareness of the radio environment. These technologies and techniques provide new opportunities for optimizing the use of spectrum and promise to make it increasingly feasible to share spectrum in real time between multiple different services and operators. ISED will take into account new approaches and the impact of new technology when assessing potential changes to spectrum allocations and when considering future spectrum releases.

In terms of opportunistic spectrum access, ISED is committed to the goal of further enabling technologies such as dynamic spectrum access, as a key component of making more spectrum available. ISED acknowledges the concerns expressed by stakeholders, but also reiterates the importance of the technology in the long term, including in the context of licensed spectrum that has not been deployed. Any regulation enabling such technologies in any particular band would be carefully considered in the context of future public consultations, providing an opportunity for stakeholders to provide additional input. It is noted that the successful implementation of such technologies requires that, among other elements, data (e.g. site information, technical characteristics and usage) is accurate and available. Further to its work in enabling database-driven whitespace technology, ISED is of the view that data accuracy is a responsibility shared by both Government and service providers alike. ISED will continue to closely monitor technology evolution and ecosystem developments, and also undertake research on technologies and techniques that improve spectrum sharing.

ISED will continue to monitor technological, market and regulatory developments in order to ensure that technical standards enable the latest advances in these areas and are aligned with spectrum releases.

8. Frequency bands for future release



This section of the Spectrum Outlook provides stakeholders with an overview of ISED's overall approach and planned activities related to ensuring appropriate spectrum resources are available to meet future demand. The approach outlined in this document is based on currently available information. In view of the rapid pace of change in spectrum demand, technology and international developments, and with due regard to the policy objectives and principles outlined in section 2 and section 3 of this document, ISED will continuously evaluate and may alter its priorities and plans for spectrum release to accommodate new uses.

Canada, like most other countries, participates in the global coordination and harmonization of spectrum management through the ITU. The Radiocommunication Sector of the ITU (ITU-R) serves to facilitate the equitable, efficient and economic use of spectrum among all radiocommunication services. The ITU-R maintains the international Radio Regulations, which define the allocation of spectrum bands to various types of services on the basis of the International Table of Frequency Allocations. The Radio Regulations are reviewed and amended at the ITU's World Radiocommunication Conferences (WRCs), which are typically held every three to four years. The last WRC was held in 2015, and the next conference is scheduled for 2019.

Canadian operators and consumers benefit from economies of scale for equipment when frequency bands are harmonized either regionally or internationally. As such, ISED takes into consideration the frequency bands that have been harmonized at the WRC as well as frequency bands that other countries have released or are in the process of releasing for which equipment is expected to be made available.

It is also important to take into account the work underway by various standards bodies since most consumer devices are based on these standards. Thus, the status of standard development can provide information regarding the timing of equipment availability. The 3rd Generation Partnership Project (3GPP) and the Institute of Electrical and Electronics Engineers (IEEE) are two of the main standards bodies for these types of devices. 3GPP develops specifications for equipment used for commercial mobile services, i.e. LTE and 5G. The IEEE develops standards for several different technologies, including Wi-Fi, Bluetooth, WiGig, ZigBee and TV Whitespace, many of which are authorized on a licence-exempt basis. These technologies are expected to be used as a large part of IoT connectivity.

Therefore, when considering potential frequency bands that could be made available between 2018 and 2022, ISED examined:

- bands opened at the recent WRC-15
- bands being considered at the upcoming WRC-19
- bands that have been released or are being considered for release in other countries
- equipment potentially being made available during the next five years

These factors, as well as the Canadian context, are discussed below for each of the frequency bands that could potentially be made available in the next five years for commercial mobile, licence-exempt, satellite and backhaul.

In the comments received as part of the consultation process, some respondents identified additional frequency bands that ISED had not addressed in the Outlook Consultation. These bands are also discussed in this section.

Each band under discussion in this document has been placed into one of three priority groups. These groups broadly indicate ISED's planned approach towards the release of each band under consideration. In determining the priority for release of each band under consideration, ISED has taken into account the factors discussed above, as well as the policy objectives outlined in section 2 of this document.

Bands identified as Priority 1 are planned for release between 2018 and 2022. These are generally bands that have established international standards, and for which equipment is available or is expected to be available. In some cases, work to make these bands available in Canada is already underway.

For bands identified as Priority 2, ISED expects to begin work (e.g. policy or technical standard development, review of existing and potential uses and/or international coordination) between 2018 and 2022. These bands could potentially be released between 2018 and 2022, subject to international developments such as WRC-19 and equipment availability.

Bands identified as Priority 3 will be regularly monitored by ISED during the period 2018 to 2022. Based on currently available information, there is uncertainty regarding the international developments or potential equipment available for these bands. Therefore, changes to the use of the bands in this group are not expected to commence until there is more clarity regarding these issues. ISED will reevaluate its assessment of these bands, as with all bands discussed in this document, should new information become available or should international developments warrant.

ISED recognizes that the variety of use cases for each service requires access to a variety of frequency ranges. ISED acknowledges the importance of a balanced approach to release, and as such, is planning on making additional spectrum

available below 1 GHz (low-band spectrum), between 1 and 10 GHz (mid-band spectrum) and above 10 GHz (high-band spectrum) as described below.

8.1 Low-band spectrum

Low-band spectrum is ideal for covering large geographic areas and for in-building penetration, making it important for both urban and rural deployments. Repurposing and releasing additional spectrum below 1 GHz will help to increase coverage and capacity in order to meet the expected increases in traffic.

8.1.1 600 MHz

The Outlook Consultation outlined the work that was already underway to repurpose the 600 MHz band and release it for flexible use. In March 2018, ISED released the *Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band*, which set out the technical, policy and licensing framework for the 614-698 MHz frequency band. Through this 600 MHz process 84 MHz of spectrum has been repurposed, freeing up 70 MHz of spectrum for flexible use of commercial mobile, fixed, or broadcasting services. As indicated through the Table of Key Dates — Technical, Policy and Licensing Framework for Spectrum in the 600 MHz Band this auction is scheduled to take place in March 2019. Therefore, this band is considered as Priority 1.

8.1.2 800 MHz

ISED indicated in the Outlook Consultation that it believed that it would be beneficial to review the 814-824 and 859-869 MHz portions of the 800 MHz band (806-824/851-869 MHz) for potential commercial mobile services in the next five years.

Current use: Currently in Canada, the 800 MHz band (806-824/851-869 MHz) is not considered commercial mobile broadband spectrum as frequencies are licensed per site on a first-come, first-served basis. The current band plan interleaves various types of users, including commercial public safety and private entity operations. This frequency band is allocated to the mobile and fixed services and is essentially divided in two blocks. The first block (806-821/851-866 MHz) allows the use of fixed point-to-point and land mobile systems. The second block (821-824/866-869 MHz) is designated for exclusive use by public safety systems. The band is highly used in Canada, specifically with a high concentration of public safety licensees within key markets throughout the entire band.

A large high-density commercial narrowband wireless system was deployed in many urban areas and is interleaved with other uses throughout the 800 MHz band. Evolution in mobile technology and a market driven by demand for mobile broadband is reducing the need for commercial narrowband wireless systems.

International context: In 2004, the United States Federal Communications Commission (FCC) adopted a plan to reconfigure the 800 MHz frequency band to address harmful interference to 800 MHz public safety communication systems caused by high-density commercial narrowband wireless systems. This process is nearing completion. Through this process 14-20 MHz of contiguous spectrum in the bands 814-824 MHz and 859-869 MHz was cleared across the United States. In 2012, the FCC revised their rules² for this spectrum such that it can now be used for commercial mobile broadband services and it is currently being used to deploy a LTE network in the United States.

² FCC, R&O, Request for Declaratory Ruling that the Commission's Rules Authorize Greater than 25 kHz Bandwidth Operations in the 817-824/862-869 MHz Band, et al, May 2012.

In addition, several countries in Asia and Latin America have deployed or plan to deploy LTE networks using spectrum within the frequency range 806-869 MHz.

Potential equipment ecosystem: Currently, there are two 3GPP band classes, Band Class 26 (814-849/859-894 MHz) and Band Class 27 (807-824/852-869 MHz), which overlaps with the spectrum cleared in the United States for commercial mobile. At present, there are both mobile devices and network equipment available for this band.

Summary of comments

Bell, Cogeco, Motorola, Nokia, RABC, Rogers, SaskTel, Sprint and TELUS agreed with ISED that the band should be reviewed to be made available for commercial mobile. Cogeco, SaskTel and TELUS recommended an early release for the band. TELUS proposed that ISED release a consultation on this band as soon as possible. Nokia and Rogers indicated that it should be part of the five-year plan and Bell proposed that it should be released in 2024. Xplornet recommended that the band be made available for both mobile and fixed wireless access and encouraged ISED to make it available within the next 12 months. RABC recommended that ISED conduct a review of the band to support the introduction of mobile in one portion of the band while ensuring its coexistence with legacy narrowband applications. BCBA and Sogetel indicated that this band has the potential to fill specific needs in rural connectivity since it is below 1GHz. RABC, Sprint and TELUS indicated that aligning with the United States would eliminate the potential for cross-border issues, and this view was also supported by Motorola in its reply comments.

Discussion

Additional commercial mobile spectrum in the 800 MHz band would provide an opportunity for mobile operators to increase their capacity and coverage over large areas. Harmonizing this band with the United States would also ease cross-border coordination, interoperability, economies of scale and roaming between countries. However, ISED recognizes that the current land mobile radio use of the 800 MHz band provides important communications for public safety and other users, that changes to one portion of the band may impact the whole band, and that changes to this band will require extensive planning. ISED will continue its review of this band with a view to developing a plan to allow for commercial mobile services, which could potentially lead to release between 2018 and 2022. Therefore, ISED considers this band as Priority 2.

8.1.3 900 MHz

The Outlook Consultation proposed that the 900 MHz band (896-960 MHz) should be reviewed to consider new uses. In November 2017, ISED began a *Consultation on the Technical, Policy and Licensing Framework for Wireless Microphones*, which included a proposal to license the operations of wireless microphones on a secondary basis in the bands 941.5-952 MHz and 953-960 MHz.

Current use: The 900 MHz frequency band has traditionally been used in Canada for land mobile, licence-exempt, paging, multipoint communications systems, narrowband-PCS and fixed services. The demand for these services in this band is low and there are relatively few licences in these bands compared to other land mobile radio bands. The licence-exempt portion is predominantly used for legacy M2M, as well as for basic IoT devices. As noted above, ISED's November 2017 consultation included a proposal to license the operations of wireless microphones on a secondary basis in the bands 941.5-952 MHz and 953-960 MHz.

International context: In Europe, the bands 896-915 MHz and 925-960 MHz have been used for commercial mobile services since the introduction of cellular technologies. Although limited, there has been some new activity internationally regarding the use of portions of the 900 MHz (896-960 MHz) band in the United States and Australia as described below.

Through the 2015 release by the FCC of the *Promoting Spectrum Access for Wireless Microphone Operators* R&O, the United States also made available additional licensed spectrum for wireless microphones in the frequency bands 941.5-944 MHz, 952.85-956.25 MHz, and 956.45-959.85 MHz, in addition to the 944-952 MHz band, which had already been available. In August 2017, the FCC released the 900 MHz Notice of Inquiry (NOI), which began an examination for potentially expanding technical and operational flexibility that could allow broadband and IoT services in the 896-901/935-940 MHz band.

In 2015, Australia decided to expand the licence-exempt portion from 902-928 MHz to 902-935 MHz in order to support low power, low duty cycle communications (e.g. smart infrastructure) given that the characteristics of this band (i.e. low-power, long-range) make it ideal for smart cities, smart grids and other IoT applications that require low bandwidth and a long battery life.

Potential equipment ecosystem: ISED is not aware of any standards work or licence-exempt devices that operate in the 928-935 MHz band. However, with the decisions in Australia and with the proximity to the existing licence-exempt band, ISED expects that equipment will become available in this band in the coming five years.

In addition, commercial mobile equipment is currently available for the overlapping bands 896-915 MHz and 925-960 MHz for European commercial mobile systems.

Summary of comments

SaskTel identified the band as a medium priority for release for commercial mobile and suggested that any review of this band must consider FCC decisions. Bell indicated that the band should be made available for commercial mobile and released in 2024. Rogers agreed with ISED's assessment of the band and recommended that ISED await the outcome of the U.S. efforts to repurpose the 896-902/935-941 MHz portion of the band prior to releasing it. TELUS identified the band as a low priority and did not express support for a particular service. Cogeco supported commercial mobile in the band and recommended an early release. CBC/Radio-Canada expressed opposition to commercial mobile in the band 953-960 MHz as it expects the use of studio transmitter links and point-to-point links in this band to grow in the coming years. CEA and FONTUR expressed support for licence-exempt in the band. RABC noted that Canadian railways are currently spectrum licensed nationally through the RAC for six channels in the 896-935 MHz and indicated that ISED should take into consideration that replacement spectrum and significant resources will be required should they decide to proceed with repacking the band.

Discussion

The 900 MHz band has similar propagation characteristics to the 800 MHz band discussed above, which would make it equally attractive for commercial mobile use. In addition, there is interest in using this band for licence-exempt applications. With the current low usage of the 900 MHz band, ISED believes that a review is warranted. However, given the ongoing consultation processes in both Canada and the United States, and continuing uncertainty regarding equipment for the various proposed uses, ISED does not expect to further its review of the 900 MHz band before 2022. Therefore, at this time, ISED considers this band as a Priority 3.

8.2 Mid-band spectrum

The characteristics of mid-band spectrum allow for a mixture of providing coverage and capacity. Releasing additional mid-band spectrum will allow wireless service providers to meet the expected increases in traffic by augmenting the quality of their existing networks and by providing targeted high capacity coverage, such as through small cell deployment.

8.2.1 L-band

ISED indicated in the Outlook Consultation that the L-band (1427-1518 MHz) or portions thereof could be released for fixed and commercial mobile use.

Current use: The L-band is used for subscriber radio service, which is limited to rural areas, and Narrowband Multipoint Communication Systems. In addition, the band 1427-1432 MHz is being used for automatic meter reading and rural telephone service while the band 1427-1429.5 MHz is available for licence-exempt medical telemetry in limited geographic areas.

In the 2012 policy decision SP 1435 MHz, *Spectrum Utilization Policy Decisions for the Band 1435-1525 MHz*, ISED decided that a review of the 1435-1525 MHz band for flexible mobile and fixed use would be postponed, given the uncertain international interest in mobile broadband systems at the time. In addition, as part of this decision, the use of aeronautical mobile telemetry in the 1452-1476 MHz band was allowed within a 320 km radius of both Downsview and Mirabel airports.

International context: The L-band (1427-1518 MHz) is a frequency band that was identified for International Mobile Telecommunications (IMT) at WRC-15. The 1427-1452 MHz and 1492-1518 MHz portions of the L-band were globally identified, whereas the band 1452-1492 MHz was identified in Regions³ 2 and 3, and over 50 countries in Region 1.

In 2013, the Electronic Communications Committee (ECC) Decision (13)03 harmonized the use of the frequency band 1452-1492 MHz in Europe for Mobile/Fixed Communications Networks Supplemental Downlink. Since 2015, authorizations have been granted for this use in the band 1452-1492 MHz in some European countries. In November 2017, Decision (17)06 also harmonized the bands 1427-1452 MHz and 1492-1518 MHz, making the whole L-band available for mobile/fixed supplemental downlink in Europe.

In addition, the Australian Communications and Media Authority released its discussion paper, *Future use of the 1.5 GHz & 3.6 GHz bands*, in December 2016, which considered the possibility of repurposing the 1427-1518 MHz frequency band to enable 5G mobile broadband.

Potential equipment ecosystem: There are currently seven 3GPP LTE band classes that cover portions of the L-band. The bands 1427.9–1462.9 MHz, 1475.9–1510.9 MHz and 1447-1467 MHz are time-division duplex (TDD) band classes 11, 21 and 45 respectively. The bands 1427-1470 MHz paired with 1475-1518 MHz is frequency division duplex (FDD) band class 74. The bands 1452-1496 MHz, 1432-1517MHz and 1427-1432 MHz are identified for supplemental downlink band classes 32, 75 and 76.

There are five 3GPP 5G band classes that cover portions of the L-band. The bands 1432-1517MHz and 1427-1432 MHz are TDD band class n50 and n51. The bands 1427-1470 MHz paired with 1475-1518 MHz is FDD band class n74. The bands 1432-1517 MHz and 1427-1432 MHz are identified for supplemental downlink band classes n75 and n76.

³ For the allocation of radio spectrum frequencies, the world is divided into three regions by the ITU: Region 1–Arab States, Africa, Europe, Commonwealth of Independent States; Region 2–Americas; and Region 3–Asia-Pacific. Further details can be found in the Canadian Table of Frequency Allocations.

Summary of comments

Bell, Ericsson, Nokia, RABC, Rogers, SaskTel, Seaside Wireless and TELUS all supported ISSED's proposal to release this spectrum for commercial mobile and fixed services in the next five years. Bell proposed that it should be high priority and that ISSED should release it in 2020. Rogers also indicated that it was high priority due to the high demand for downlink. TELUS indicated that it was a medium-high priority.

Discussion

ISSED believes that L-band will be an important band for future 5G deployments as it is globally harmonized and there is expected to be a global equipment ecosystem. ISSED considers that the L-band or portions thereof could be released for fixed and mobile use, given that there is little current use of this band in Canada. However, there are potential interference issues at the border as the United States currently operates aeronautical mobile telemetry in the band, which internationally has priority over the mobile service in a portion of the L-band. ISSED intends to begin work with the United States to develop a cross-border arrangement for this band, with a view to releasing it for flexible fixed and mobile use in Canada as soon as possible. As this process has the potential to continue beyond 2022, this band is considered as Priority 2.

B.2.2 1500 MHz and 1600 MHz Ancillary Terrestrial Component (ATC) bands

ISSED received comments on ATC initiatives in the bands 1525-1559 MHz paired with 1626.5-1660.5 MHz (1500 MHz) and 1610.5-1626.5 MHz paired with 2483.5-2500 MHz (1600 MHz), as well as on U.S. developments in the 1670-1680 MHz band.

Current use: The 1525-1559 MHz and 1626.5-1660.5 MHz and 1610.5-1626.5 MHz and 2483.5-2500 MHz bands are currently used to provide MSS services in Canada, and have been for a number of years. Specifically, portions of the bands 1525-1559 MHz and 1626.5-1660.5 MHz are being used by Inmarsat and Ligado Networks for MSS, while the 2483.5-2500 MHz band and portions of the 1610.5-1626.5 MHz band are being used by Globalstar Canada for MSS. In January 2017, ISSED received a licence application for ATC from Globalstar Canada, which sought rule changes for operating low-power ATC in their licensed band (2483.5-2500 MHz). ATC is already allowed in these bands as per RP-023 – *Spectrum and Licensing Policy to Permit Ancillary terrestrial Mobile Services as Part of Mobile-Satellite Service Offerings* and ISSED is intending to consult on changes to this policy in the near term.

International context: ISSED notes that Canadian MSS operators must coordinate their use of these MSS bands with other MSS operators internationally, which is the reason that they are only using portions of these bands in most cases.

There is currently no primary mobile service allocation in the 1525-1559 MHz and 1626.5-1660.5 MHz bands. In April 2016, the United States issued a public consultation (DA-16-442) on an application by Ligado to modify the ATC of its L-band MSS networks in the bands 1525-1559 MHz and 1626-1660.5 MHz to minimize the potential interference to GPS systems operating in the band and allow them to deploy a broadband network. At the same time, the United States also published a consultation (DA-16-443) on Ligado's request that the FCC initiate a rulemaking to allocate 1675-1680 MHz band for terrestrial mobile use shared with federal use. This would allow a 10 megahertz contiguous block of spectrum (1670-1680 MHz), as the 1670-1675 MHz band was already allocated and auctioned for terrestrial mobile use in the United States. To date, the FCC has not made a decision on these consultations.

In December 2016, the FCC modified its rules to grant Globalstar's ATC request in the 2485.5-2495 MHz band with a condition of licence that MSS services be maintained.

Potential equipment ecosystem: Ecosystems for terrestrial mobile use in the MSS/ATC bands are currently being discussed and developed, and are expected to be dependent on sufficient global spectrum availability.

Summary of comments

Rogers proposed that ISED should monitor the ongoing proceedings in the United States, and any further actions from the FCC regarding efforts by Ligado and Globalstar to offer mobile services in their MSS spectrum. With respect to Ligado's request to allocate the 1675-1680 MHz band for commercial mobile use, Rogers proposed that should Ligado be successful in the United States, ISED should also consider making this spectrum available for commercial mobile services in Canada. In its reply comments, Bell supported Rogers' proposal. No other respondents addressed these bands.

Discussion

Recognizing the current MSS use in the 1500 MHz and 1600 MHz bands, as well as continued interest by MSS operators in further using these bands for ATC within the next five years, facilitating additional use in these bands is considered Priority 1. ISED will initiate a review of RP-023 in late 2019, with a view to enabling further use of these bands where possible, while recognizing the ongoing importance of providing MSS services. With respect to the 1675-1680 MHz band, ISED will closely monitor the developments in the United States

8.2.3 AWS-2 and AWS-3 unpaired

The Outlook Consultation proposed that the bands 1915-1920 MHz and 1995-2000 MHz (AWS-2, or H-Block) and 1695-1710 MHz (AWS-3 unpaired) could be released for commercial mobile.

Current use: In 2007, through DGTP-002-07, *Consultation on a Framework to Auction Spectrum in the 2 GHz Range including Advanced Wireless Services*, AWS-2 was designated for commercial mobile use and was held in reserve until technical issues related to possible interference with existing PCS use (resulting from the narrow duplex separation) and with mobile-satellite service above 2000 MHz were addressed. The AWS-3 unpaired spectrum is allocated to meteorological aids and meteorological-satellite (space-to-earth) services. Various systems, such as meteorological earth stations and weather balloons, are deployed in this band. As well, the frequency band 1700-1710 MHz is used for low-capacity point-to-point microwave systems, such as one-way audio studio transmitter links.

International context: AWS-2 or H-Block was auctioned in the United States in early 2014, with one major national licensee. The AWS-3 unpaired band was also auctioned in the United States in 2014 as part of its AWS-3 auction. This block was unpaired, and the majority of the licences were assigned to the same licensee as the H-Block.

Potential equipment ecosystem: In the United States, the AWS-2 and the AWS-3 unpaired, in addition to the AWS-4 (2000-2020 MHz and 2180-2200 MHz) spectrum, are held by the same licensee nationwide. As such, the expected equipment ecosystems for these blocks of spectrum are linked and 3GPP band class 70 pairs the band 1695-1710 MHz (AWS-3 unpaired) with 1995-2020 MHz (upper portion of H-block and lower portion of AWS-4).

Summary of comments

Nokia, SaskTel, Sogetel and TELUS all supported the release of AWS-2 and AWS-3 unpaired for commercial mobile. SaskTel classified it as a low-priority while TELUS considered it a medium-priority. TerreStar indicated that the AWS-2 and AWS-3 unpaired spectrum should be for fixed and mobile use, and that it should be a high priority for release. Rogers supported the release of AWS-3 unpaired for commercial mobile as a high priority. For AWS-2, Bell Mobility recommended that ISED

wait until the status of this spectrum becomes more certain in the United States before initiating a licensing process, and for AWS-3 they agreed that this band should be auctioned once the equipment ecosystem is established. TELUS indicated that H-Block could be used either with other bands through carrier aggregation or with AWS-3. Given this, it recommended that H-Block be released through a competitive licensing process.

Discussion

ISED does not intend to move forward towards the release of these bands until there is more clarity regarding a potential equipment ecosystem, in particular given the linkages to AWS-4 spectrum. Therefore, pending further developments in the United States, ISED considers these bands as Priority 3.

8.2.4 3500 MHz and 3800 MHz

ISED indicated in the Outlook Consultation that it would review the frequency ranges from 3400-4200 MHz to consider releasing it, or portions thereof for commercial mobile and fixed use. ISED is defining the 3500 MHz band as the frequency range 3450-3650 MHz, and the 3800 MHz band as the frequency range of 3650-4200 MHz. The 3400-3450 MHz is band being treated separately.

Current use: The frequency range from 3400-4200 MHz is currently used for radiolocation, fixed point-to-point, FWA, WBS and the FSS systems. The 3400-3475 MHz portion of the band is reserved for use for aeronautical and maritime radars, although some radars also operate as high as 3650MHz. The band 3475-3650 MHz is currently being used for FWA systems; however, in DGSO-007-14, *Decisions Regarding Policy Changes in the 3500 MHz band (3475-3650 MHz) and a New Licensing Process* (referred to as the 2014 Decision), ISED indicated this band will be subject to a future consultation for mobile use. To this end, ISED published SLPB-004-18, *Consultation on Revisions to the 3500 MHz Band to Accommodate Flexible Use and Preliminary Consultation on Changes to the 3800 MHz Band (3500/3800 MHz Consultation)*.

The band 3650-3700 MHz is available for WBS, which is licensed on a shared basis and can be used for both fixed and mobile applications. There are currently limited fixed point-to-point links in operation in the 3400-3475 MHz and 3700-4200 MHz portions of the band. The band 3700-4200 MHz is primarily used by the FSS for the delivery of broadband services as well as feeder links for television broadcasts. In addition, there are unlicensed broadcast receivers used to receive TV programming from satellites, which are used to distribute TV programming over cable infrastructure or in broadcast studios to receive multimedia to create programming.

International context: Portions of the 3500 MHz and 3800 MHz bands are either already available or being made available for commercial mobile or flexible use in several countries, including the United States, the United Kingdom, Australia, Ireland, Japan, South Korea, China and Singapore. The 3500 MHz and 3800 MHz bands are viewed as key spectrum to support 5G technologies, and many countries have begun work to make this spectrum available for this purpose.

In 2015, the FCC made the 3550-3700 MHz band (150 MHz) available for flexible use on a shared basis through a database-supported authorization system, known as the Citizen Broadband Radio Service (CBRS). In August, 2017, an NOI, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*, indicated the FCC was exploring the opportunity to expand CBRS up to 4200 MHz. In October 2017, the FCC launched a consultation on potential changes to the licensing rules in this band to support 5G deployments, as the original framework was developed before it was apparent that the 3500 MHz band would play a significant role as one of the key mid-range bands for 5G network deployments throughout the world.

In November 2016, the European Commission's Radio Spectrum Policy Group (RSPG) provided an *Opinion on spectrum related aspects for next-generation wireless systems (5G)*. The Opinion stated that the RSPG considers the 3400-3800 MHz band as the primary suitable band for the introduction of 5G technologies in Europe. Several European countries have

recently released or announced a plan to release portions of the band 3400-3800 MHz for flexible fixed and mobile use through competitive processes.

Equipment ecosystem: There are currently three 3GPP LTE TDD band classes available that cover portions of the 3500 MHz and 3800 MHz bands. The bands 3400-3600 MHz and 3600-3800 MHz bands are covered by band classes 42 and 43, respectively. Band class 48 covers the U.S. 3550-3700 MHz band. Fixed LTE equipment has existed for significant periods of time for bands 42 and 43. LTE fixed and mobile equipment is being developed for band 48.

There are also two 3GPP 5G TDD band classes that cover the 3500 MHz and 3800 MHz bands. The band 3300-4200 MHz is band class n77 and the band 3300-3800 MHz is band class n78.

Summary of comments

Stakeholders were supportive of ISED reviewing the entire frequency range 3400-4200 MHz. Cisco, Cogeco, Nokia, Qualcomm, Québecor, SaskTel, Shaw, Sogetel and TELUS indicated that the release of the 3500 MHz band is a high priority. Cisco, Nokia, Qualcomm, Québecor, SaskTel and Shaw indicated the importance of the band for commercial mobile, while Bell, Cogeco, Rogers and TELUS suggested making it available for flexible use.

Bell suggested making frequency range 3400-3800 MHz available for flexible use and reallocating the existing C-Band satellite users into the frequency range from 3800-4200 MHz. Cogeco, Rogers, Sogetel and Xplornet suggested that ISED harmonize the band in Canada with frameworks adopted in the rest of the world. TELUS stated that Canada is in a prime position to immediately embark on the process of releasing the band for flexible use with different portions of the band being released at different times. More specifically, TELUS suggested that ISED release the 3475-3650 MHz band by mid-2019, and consult on the full 3400-4200 MHz band in the longer term.

DSA, Microsoft and Motorola proposed that ISED adopt a database approach for this band like the United States. Microsoft argued that it would not require re-banding or relocation of incumbent service. DSA suggested that ISED adopt a three-tiers-of-access spectrum management framework for the 3550-3700 MHz frequency band that is harmonized with the United States. DSA also suggested that ISED consider rule changes that will facilitate the fixed service sharing spectrum with FSS downlinks in the 3700-4200 MHz frequency band through a simple database coordination process.

BCBA, Cape Breton Regional Municipality, Fire Service Association of Nova Scotia, Municipality of the County of Antigonish, Municipality of the County of Colchester, Municipality of the County of Cumberland, Municipality of the County of Richmond, Municipality of the County of Victoria, EOWC and EORN, and Seaside Wireless urged ISED to ensure continued equitable access for FWA providers in the 3500 MHz band. CanWISP proposed that ISED expand the current WBS band rules into the band 3700-4200 MHz to allow for increased FWA deployment in rural areas. SES and Telesat indicated that satellite use of this band should be protected. However, none of the stakeholders indicated opposition to reviewing the use of the band.

Discussion

Comments received indicated a strong interest in releasing the 3500 MHz band for flexible use as quickly as possible. Given the international interest in the 3500 MHz band with the expectation of it being a key band for the development of 5G services and the expected timeline for a global equipment ecosystem, as well as domestic interest in this band, ISED considers 3500 MHz as Priority 1 and has released the 3500/3800 MHz Consultation on accommodating flexible use in the 3500 MHz band. ISED is anticipating 3500 MHz spectrum will be released for flexible use in late 2020.

ISED considers the 3800 MHz band as Priority 2, and has begun a preliminary review of the band as part of the 3500/3800 MHz Consultation.

8.2.55 GHz

The Outlook Consultation discussed the 5 GHz (5150-5925 MHz) band but did not propose any specific changes to the band pending potential outcomes of WRC-19. However, ISED did receive comments proposing that different portions of the 5 GHz band be made available for licence-exempt devices.

Current use: In Canada, the frequency bands 5150-5350 MHz, 5470-5600 MHz, and 5650-5850 MHz are available for licence-exempt applications, in particular for Radio Local Area Network (RLAN) devices, typically Wi-Fi devices, and the current technical rules are aligned with the international framework (i.e. Radio Regulations). ISED is actively participating in the discussion regarding technical changes to these bands and will consult on any changes made at WRC-19. However, ISED previously received some expressions of interest from Canadian stakeholders to consider changes to the 5150-5250 MHz band. Therefore, following a consultation, ISED released SMSE-013-17, *Decision on the Technical and Policy Framework for Radio Local Area Network Devices Operating in the 5150-5250 MHz Frequency Band*, which modified the technical and policy framework for RLAN devices operating in the 5150-5250 MHz frequency band to allow the use of higher power RLAN devices, both indoor and outdoor, under a licensed regime.

The 5350-5470 MHz band is used by the Canadian Space Agency's RADARSAT earth exploration satellites. These satellites provide images of the earth from space and allow for mapping, marine surveillance, ice and environmental monitoring, and disaster and resource management. The RADARSAT satellites provide data to the Government of Canada, as well as to many agencies in the United States and to private users worldwide. This band has been the subject of years of domestic and international work to find suitable mitigation measures to ensure protection of RADARSAT, and ISED will continue these efforts leading into WRC-19. There is currently no primary mobile allocation in this sub-band, and EECS (active) allocations in the bands 5350-5460 MHz and 5460-5470 MHz are essential for Earth-observation programs, including RADARSAT, whose data is vital for reliable and up-to-date information on how our planet and its climate are changing.

As per the CTFA, the 5600-5650 MHz band is allocated to maritime radionavigation, mobile (except aeronautical mobile) and radiolocation. Currently, this band is licensed and used by Environment Canada for weather radars. Radio Standard Specifications (RSS)-247, *Digital Transmission Systems (DTSs)*, *Frequency Hopping Systems (FHSs)* and *Licence-Exempt Local Area Network (LE-LAN) Devices* does not allow RLAN devices to transmit in the 5600-5650 MHz frequency band to ensure Environment Canada's weather radars are protected accordingly.

In Canada and in the United States, the band 5850-5925 MHz is designated for use by dedicated short-range communications (DSRC) in support of intelligent transport systems (ITS). The ITU defines ITS as systems that utilize a combination of computers, communications, positioning and automation technologies to improve the safety, management and efficiency of terrestrial transportation. Many ITS applications require radio spectrum, since they involve communications with moving vehicles. DSRC deployments began in 2017. As such, through SAB-001-17, *Displacement of Existing Fixed Service Assignments in the Frequency Band 5850-5925 MHz*, ISED allowed the introduction of vehicle-mounted DSRC devices in the band 5850-5925 MHz and initiated the displacement of fixed service assignments in that frequency range.

International context: Internationally, the 5 GHz range is sub-divided into a number of frequency bands, each allocated to various services. Within this range, the frequency bands 5150-5350 MHz and 5470-5850 MHz are available for RLAN and are typically used for licence-exempt applications (e.g. Wi-Fi, LTE-U and LTE-LAA). Given the variety of incumbent services sharing the bands 5150-5350 MHz and 5470-5850 MHz (e.g. radars, EECS and MSS), there are different measures (e.g. power level restrictions, a requirement to use dynamic frequency selection and limitations on outdoor use) in place in these

bands to facilitate the coexistence between licence-exempt devices and other services. WRC-19 agenda item 1.16 will consider whether restrictions in some of these bands can be relaxed to facilitate RLAN use while continuing to ensure coexistence with other services.

In addition, in 5 GHz frequency bands that are not currently available for RLAN (i.e. 5350-5470 MHz, and 5850-5925 MHz), WRC-19 agenda item 1.16 will also address whether or not mitigation measures can be adopted to enable the introduction of new RLAN uses, while ensuring protection of other existing and planned services.

In the United States, as in Canada, the 5850-5925 MHz band is designated for use by DSRC in support of ITS. The FCC is currently undertaking a study to assess the possible coexistence of Wi-Fi with DSRC technology in the 5850-5925 MHz band. Depending on the findings of that study, possible approaches of sharing could include "detect and avoid" where DSRC signals are detected and use of the channel is avoided upon detection; or "re-channelization" where safety critical communication is migrated to the upper section of the band, and the lower part of the band would be shared with non-critical communications.

On a worldwide level, cellular vehicle-to-everything (C-V2X) type communication, developed by 3GPP, is gaining traction. C-V2X is designed to operate in the 5850-5925 MHz to also support ITS. C-V2X is being adopted by members of the 5G Automotive Association, which is a global, cross-industry organization of companies from the automotive, technology, and telecommunications industries who are seeking to develop end-to-end solutions for future mobility and transportation services.

Potential equipment ecosystem: There is currently a globally harmonized equipment ecosystem for the bands 5150-5350 MHz and 5470-5850 MHz for Wi-Fi. There are two TDD LTE band classes in the 5 GHz range. Band class 46 covers the whole range of 5150-5925 MHz, and band class 47 covers the DSRC portion 5850-5925 MHz.

In the United States, DSRC technology is authorized for both on-board units and road-side units in the band 5850-5925 MHz. There have also been developments to use this band for cellular based C-V2X type communications in support of ITS. In particular, 3GPP recently developed its Release 14 specifications, which facilitate C-V2X.

Should WRC-19 adopt changes for the existing 5 GHz bands or make new bands available, ISED expects that the Wi-Fi industry will make equipment available within two to three years of the following WRC.

Summary of comments

Most respondents identified 5 GHz as one of the licence-exempt bands that will see the most evolution over the next five years. Respondents also anticipate the trend of offering carrier-grade or managed Wi-Fi to grow, and the 5 GHz band to be affected by this trend.

CanWISP, DSA, Microsoft, Québecor and Telrad Networks commented on the anticipated congestion of the 5 GHz band. Cogeco Communications, Microsoft and Shaw broadly supported the release of additional spectrum in the 5 GHz band.

DSA proposed that Canada support outdoor and higher power RLAN in the 5150-5350 MHz band at WRC-19 (agenda item 1.16). Shaw, in their reply comments, indicated that ISED should ensure that higher power outdoor use of RLAN in the 5150-5250 MHz band not be impacted by the outcome of WRC-19. Bell also supported the use of higher power RLAN devices both indoor and outdoor under a licensed regime basis. Cisco argued that the limited access to higher power Wi-Fi devices in the 5150-5250 MHz, and the use of the 5600-5650 MHz solely for weather radars, provide Canadians with slower Wi-Fi speeds compared to the United States.

Québecor and Wi-Fi Alliance supported the release of 5350-5470 MHz for licence-exempt use. Cisco and Shaw urged ISED to allow RLAN devices in the 5600-5650 MHz frequency band. Québecor, Rogers and Shaw supported the sharing of RLANS with DRSC in the 5850-5925 MHz frequency band, while Québecor supported the release of the band for licence-exempt use.

Discussion

ISED is actively participating in the WRC-19 agenda item 1.16 discussions, which address the potential adoption of mitigation measures to enable the introduction of new RLAN uses, while ensuring protection of other existing and planned services in the 5 GHz band. Should additional 5GHz bands be made available at WRC-19 for wireless local area network applications, ISED will consider if they should also be made available in Canada at that time. Recognizing the importance of allocating and reserving spectrum for the safe deployment of connected vehicles, ISED will continue to reserve the 5850-5925 MHz spectrum for connected vehicle applications. Any additional use of this spectrum for other applications, such as Wi-Fi, would only be permitted if ISED is confident that coexistence within the band is possible. Broad consultation with affected stakeholders, including the automotive and wireless industries, connected vehicle equipment manufacturers, and other levels of government would be required as part of this determination. ISED may consider the use of licence-exempt devices in the 5600-5650 MHz band at an opportune time. Due to uncertainty surrounding the future international framework and potential for coexistence with other services, ISED considers the 5 GHz band as Priority 3, but may advance the work depending on the outcome of WRC-19 and other activities in this band.

8.2.6 6 GHz

The 6 GHz (5925-6415 MHz and 6415-7125 MHz) band was not discussed in the Outlook Consultation. However, ISED received several comments proposing the release of this band in the next five years for commercial mobile and/or licence-exempt use.

Current use: In Canada, 5925-7125 MHz is used for fixed services and FSS. The bands 5925-6425 MHz and 6425-7125 MHz are heavily used for two-way backhaul, with 6425-7125 MHz also used for TV auxiliary services and studio transmitter links. The band 5925-6425 MHz is the upper portion of the C-band (typically paired with 3700-4200 MHz), which is used for uplink communication for FSS for the delivery of broadband services and to distribute TV programming.

International context: In August 2017, the FCC released an NOI, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz* in which it sought comments for flexible access, particularly for wireless broadband services, in the 3.7 to 24 GHz band. While comments were sought for the full 3.7 to 24 GHz band, the NOI focused mainly on the 5925-6415 MHz and 6415-7125 MHz bands since stakeholders had already expressed interest in additional flexible broadband use of these bands. The FCC sought comments regarding the potential for flexible wireless broadband use of 5925-6415 MHz and for more intensive terrestrial fixed or mobile use of the band 6415-7125 MHz band, with a focus for potential licence-exempt uses such as Wi-Fi, LTE-U and LTE-LAA.

In 2017, the ECC began a work item examining the feasibility of introducing lower power wireless access systems (WAS) including RLANs, in the 5925-6425 MHz band (WAS/RLAN 6 GHz).

Potential equipment ecosystem: ISED is not aware of commercially available equipment that would operate in a licence-exempt fashion in the 6 GHz band. However, as indicated above, there is a general interest in considering the 6 GHz band for licence-exempt and flexible use in the United States and in Europe.

Summary of comments

Comments regarding the 6 GHz band were divided in three main themes. In general, manufacturers recommended licence-exempt use of the band, service providers proposed flexible or commercial mobile use and incumbents requested protection of their existing systems if new services are introduced in the 6 GHz band.

Cisco, DSA, Facebook, Microsoft, Shaw and Wi-Fi Alliance specifically recommended that ISED allow licence-exempt technologies in this band. Cisco and DSA commented that the 6 GHz band being adjacent to the 5 GHz band could result in a reduction in equipment costs, especially for Wi-Fi type devices. Microsoft expressed that the 6 GHz band was an opportunity to address anticipated congestion in the 5 GHz licence-exempt bands.

Bell Mobility supported flexible use of the band and Bell and Rogers suggested ISED wait for the outcome of the United States and other international consultations on this band before making a final determination. In general, TELUS supported flexible or commercial mobile use. Although they prefer a licensed regime, TELUS would support licence-exempt use if this approach is taken in the United States and other countries.

SES and Telesat, in reply to initial comments, recommended that ISED carefully study possible coexistence between licence-exempt devices and incumbents prior to initiating a consultation for the 6 GHz band, in light of interference concerns. In its reply comments, Rogers stressed the essential need for fixed backhaul services in the 6 GHz band. Decawave mentioned that their customers use the band to design, manufacture and deploy ultra-wideband equipment and is very concerned that these existing and rapidly expanding deployments will be severely disrupted if new higher-powered unlicensed transmitters are allowed in the 6 GHz band.

Discussion

ISED recognizes that the 6 GHz band is currently heavily used for backhaul and satellite communications. However, ISED is of the view that co-existence of this band between existing and certain new services may be possible depending on the technical and operational characteristics that are implemented in the equipment to protect existing services. Therefore, ISED will continue to monitor the United States and other international developments of the 6 GHz band, and will revisit the priority of the band should there be significant advancements internationally. Based on currently available information, ISED considers this band as Priority 3.

8.3 High-band spectrum

Releasing spectrum in high bands will allow service providers to obtain large blocks of spectrum to increase the capacity and quality of their networks, and will promote innovation by supporting new technologies and business models.

There is significant interest internationally in releasing high-band or mmWave spectrum, particularly above 20 GHz, for all four of the services and applications that were considered in the Outlook Consultation. Based on the propagation characteristics of these bands and the expected evolution of technologies and techniques that can facilitate spectrum sharing between different services, there is interest internationally in using these bands for multiple services wherever possible.

Of particular importance is that WRC-19 will consider five different agenda items for different services with studies in overlapping frequency bands above 20 GHz:

- Agenda item 1.5: to consider the use of the frequency band 27.5-29.5 GHz (Earth-to-space) by ESIM communicating with geostationary space stations in the fixed-satellite service. The band 17.7-17.9 GHz (space-to-Earth) will also be considered as part of this agenda item.

- Agenda item 1.6: to consider the development of a regulatory framework for NGSO FSS satellite systems
- Agenda item 1.13: to consider identification of frequency bands for the future development of IMT
- Agenda item 1.14: to consider appropriate regulatory actions for high-altitude platform stations (HAPS)
- Agenda item 9.1 issue 9.1.9: to consider spectrum needs and possible allocation of the frequency band 51.4-52.4 GHz to the fixed-satellite service (Earth-to-space)

Table 1 below shows the frequency bands that are being considered under each agenda item, and where bands are being considered under multiple agenda items.

Table 1: WRC-19 agenda items related to frequency bands above 20 GHz

Agenda item 1.5 ESIM	Agenda item 1.6 NGSO FSS	Agenda item 1.13 IMT	Agenda item 1.14 HAPS	Agenda item 9.1 issue 9.1.9 FSS
			21.4-22 GHz	
		24.25-27.5 GHz	24.25-27.5 GHz (Region 2 only)	
27.5-29.5 GHz				
		31.8-33.4 GHz		
	37.5-42.5 GHz (space-to-Earth)	37-42.5 GHz	38-39.5 GHz	
		42.5-43.5 GHz		
		45.5-47 GHz		
		47-47.2 GHz		
	47.2-50.2 GHz (Earth-to-space)	47.2-50.2 GHz		
	50.4-51.4 GHz (Earth-to-space)	50.4-52.6 GHz		51.4-52.4 GHz (Earth-to-space)
		66-76 GHz		
		81-86 GHz		

Canada is actively involved, both domestically and internationally, in work related to these agenda items. These frequency bands will be reviewed, based both on their potential contribution towards global spectrum harmonization as well as their impact on existing users. It is anticipated that WRC-19 will find sufficient spectrum and/or adjust the regulatory framework to support these services.

In addition to the work underway at the ITU, several countries have also started to consider or release bands above 20 GHz for fixed service, mobile service and licence-exempt applications in preparation for the 5G applications that require high throughput over short distance.

In July 2016, the FCC released the *Spectrum Frontiers Report and Order (R&O) and Further Notice of Proposed Rulemaking (FNPRM)* regarding the use of frequency bands above 24 GHz. As part of the R&O, the FCC made the 28 GHz (27.5-28.35 GHz), 37 GHz (37-38.6 GHz) and 38 GHz (38.6-40 GHz) bands available for flexible mobile and fixed use, the band 64-71 GHz available for licence-exempt use. In the FNPRM, the FCC sought comments on authorizing fixed and mobile use of the following bands: 24.25-24.45 GHz together with 24.75-25.25 GHz (24 GHz band), 31.8-33 GHz (32 GHz band), 42-42.5 GHz (42 GHz band), 47.2-50.2 GHz (47 GHz band), 50.4-52.6 GHz (50 GHz band), and the 71-76 GHz band together with the 81-86 GHz bands (70/80 GHz bands). In addition, they sought comments on the possibility of using some of these bands for licence-exempt, as well as on the use of bands above 95 GHz. Following this, the FCC released a Second R&O, Second FNPRM and Memorandum Opinion and Order in November 2017. In the Second R&O, the FCC made the 24 GHz and 47 GHz bands available for flexible terrestrial wireless use. In the Second FNPRM, the FCC is seeking comments to allow more flexible FSS use of the 24.75-25.25 GHz band. In the Memorandum Opinion and Order, the FCC maintained the bands 48.2-50.2 GHz and 40-42 GHz as core satellite bands (including end user devices). In April 2018, the FCC made the pre-auction announcement for the mmWave bands 28 GHz and 24 GHz. The 28 GHz band will be auctioned first in November 2018 and then, shortly thereafter, the 24 GHz band.

In November 2016, the European Commission's RSPG provided an *Opinion on spectrum related aspects for next-generation wireless systems (5G)*, which recommended that Europe develop harmonization measures for the frequency band 24.25-27.5 GHz before 2020, and that the frequency bands 31.8-33.4 GHz and 40.5-43.5 GHz should not be further encumbered so as not to preclude making them available for 5G in the future. As part of the United Kingdom's Office of Communications' 2016 update of their *Mobile Data Strategy*, they indicated that the bands above 24 GHz are a high priority and that it is examining whether either 24.5-27.5 GHz or 31.8-33.4 GHz could be utilised for early implementation.

As part of the Outlook Consultation, ISED proposed that all of these bands could be considered for potential release in the next five years. The following provides an overview and a summary of comments received for each band, as well as ISED's plan for releasing high-band spectrum for the different services.

8.3.1 Extended 23 GHz

The Outlook Consultation did not discuss any potential new uses of the bands 21.2- 21.8 GHz and 22.4- 23 GHz (Extended 23 GHz). However, ISED received comments indicating that they should be considered for release for backhaul use.

Current use: The band 21.2-21.4 GHz is allocated to the EESS (passive), fixed service and space research (passive) on a co-primary basis. The band 21.4-21.8 GHz is allocated to the fixed service on a primary basis. The band 22.4-22.5 GHz is allocated the EESS (passive), fixed service, radio astronomy and space research (passive) on a co-primary basis. The band 22.5-22.55 GHz is allocated to fixed service on a primary basis. The band 22.55-23 GHz is allocated to the inter-satellite service, fixed service and space research (Earth-to-space) on a co-primary basis. SP 23/38 GHz, *Spectrum Policy and Licensing Considerations, Fixed Radio Systems in the 23 GHz and 38 GHz Frequency Bands* designated the bands 21.2-21.6 GHz and 22.4-22.8 GHz for MCS and reserved the bands 21.6-21.8 GHz and 22.8-23 GHz for future designation. The bands 21.2-21.8 GHz and 22.4- 23 GHz are currently lightly used.

International context: The Extended 23 GHz band is available for backhaul in the United States.

Potential equipment ecosystem: There is currently backhaul equipment available that covers the range 21.2-21.8 GHz and 22.4-23 GHz, as well as the adjacent bands 21.8-22.4 GHz and 23-23.6 GHz.

Summary of comments

Ericsson and the RABC proposed that these bands be released for backhaul use. Ericsson proposed that ISSED release them immediately as other backhaul spectrum is congested and heavily used, and since there is an equipment ecosystem readily available. The RABC indicated that adding these bands would extend the existing 23 GHz backhaul band and noted that these bands are currently vacant.

Discussion

As discussed in section 6.5, it is expected that there will be a need for additional backhaul spectrum to accommodate the expected increase in demand over the next five years. The bands 21.2-21.8 GHz and 22.4-23 GHz can be used to increase the amount of backhaul spectrum available since they are a natural extension to the existing 23 GHz backhaul band, and have readily available equipment. However, ISSED must consider the potential impact of backhaul on the other services currently using the band. ISSED considers the Extended 23 GHz band as Priority 2 for potential backhaul use.

8.3.2 24 GHz and 26 GHz

The Outlook Consultation proposed that the range 24.25-27.5 GHz could be released for commercial mobile, fixed and/or licence-exempt use. ISSED will consider two bands within this range separately: 24.25-26.5 GHz (24 GHz) and 26.5-27.5 GHz (26 GHz).

Current use: In the 24 GHz band, specific portions are allocated on a primary basis to the fixed, mobile, radionavigation and different types of satellite services. Currently, this frequency range is used in Canada by various services, including the fixed service (mostly in major urban centers) and FSS (Earth-to-space) feeder links.

There are various satellite services operating in the 26 GHz band. The frequency range 26.5-27 GHz has primary allocations for fixed, mobile, EESS (space-to-Earth), space research (space-to-Earth) and inter-satellite services (ISS). There are currently no licences issued within this frequency range other than one EESS satellite licence in the 26.5-27 GHz band. The frequency range 27-27.5 GHz has primary allocations for fixed, mobile, FSS (Earth-to-space) and ISS. There are no licences issued within this frequency range.

International context: As discussed above, both the 24 GHz and 26 GHz bands are currently being studied for potential commercial mobile and HAPS use in ITU-R Region 2.

The WRC-19 will consider the identification of the 24.25-27.5 GHz band for the future deployment of mobile broadband services. Preliminary international studies are converging toward feasible sharing among mobile broadband services and satellite services in the 26 GHz band. However, international studies for the 24 GHz band are not as mature.

In November 2017, the FCC made available the frequency bands 24.25-24.45 GHz and 24.75-25.5 GHz for flexible terrestrial wireless use. The FCC will auction the 24 GHz band following the planned November 2018 auction of the 28 GHz. In March 2018, New Zealand consulted on releasing the frequency band 24.25-28.35 GHz in support of 5G. Europe, China and Australia have expressed intent to use all or parts of the frequency band 24.75-27.5 GHz for 5G services.

Potential equipment ecosystem: The 3GPP has identified two band-classes in the 24.25-29.5 GHz frequency range: band n257 for 26.5-29.5 GHz and band n258 for 24.25-27.5 GHz for the development of 5G/NR systems.

Summary of comments

Stakeholders generally supported ISED's proposals for this band, but some comments were received regarding the continued access of part of the band for FSS. Bell, TELUS and TeraGo supported flexible use of the band and indicated that it should be considered a high priority for release. Rogers indicated that the band holds great potential for both commercial mobile and fixed services and indicated that it should be considered the second highest priority for mmWave bands after the 27.5-28.35 GHz and 37-40 GHz bands. Cogeco, Huawei Canada, Nokia and Shaw recommended that ISED open the band for 5G and Nokia further indicated that it presents an excellent opportunity for global harmonization and implementation. SaskTel supported commercial mobile in the band but indicated that the release of this band should be considered a low-priority and that ISED should wait for the WRC-19 decisions. Hughes Canada proposed to reserve the band 24.25-25.25 GHz for FSS. RABC supported both fixed and mobile co-primary allocations within the band (24.25-24.45 GHz, 25.05-25.25 GHz and 25.25-26.5) where needed to enable terrestrial flexible use but also indicated that consideration should be given to maintain FSS use in 24.75- 25.25 GHz. SES stated that, if ISED introduces additional services in the 24.75-25.05 GHz band or the 25.05-25.25 GHz band, FSS should retain access on a co-primary basis. Telesat stated that any release of the band to commercial mobile, fixed or licence-exempt use should provide for continued use of 24.75- 25.25 GHz band for FSS.

Discussion

Comments received indicated a strong interest in releasing the 24.25-27.5 GHz band as a priority. ISED considers the 26 GHz band as Priority 1. This view is supported by two 5G 3GPP band classes, international interest in the 26 GHz band, the expectation of the band being a key band for the development of 5G services and the expected timeline for a global equipment ecosystem, as well as domestic interest in this band. As such ISED has released SLPB-005-18 — *Addendum to the Consultation on Releasing Millimetre Wave Spectrum to Support 5G* an addendum to the *Consultation on Releasing Millimetre Wave Spectrum to Support 5G* to also consider this band for release for flexible use in the same timeframe.

Recognizing that the 24 GHz band is under discussion at WRC-19 and within other countries and there may be some concerns regarding sharing with other services, ISED considers the band as Priority 2. ISED will continue to monitor these developments to determine when, and for which services, these bands should be made available.

8.3.3 28 GHz, 37-40 GHz and 64-71 GHz

As indicated in the Outlook Consultation, ISED has begun the process to potentially release these bands to support the deployment of 5G. In June 2017, ISED released SLPB-001-17, *Consultation on Releasing Millimetre Wave Spectrum to Support 5G*, which sought comments on releasing the 28 GHz (27.5-28.35 GHz) and 37-40 GHz frequency bands for flexible fixed and mobile use, and the 64-71 GHz frequency band for licence-exempt use. The comments received as part of the Outlook Consultation on these bands reiterated their importance for 5G deployments and that they should be prioritized for release within the next five years. As such, ISED continues to treat this process as a Priority 1 and expects to release these bands for terrestrial flexible use and other services in late 2021.

8.3.4 32 GHz

As indicated in the Outlook Consultation, through the Backhaul Decision, ISED made provision for additional spectrum to be made available to accommodate backhaul-associated applications in the 32 GHz band (31.8-33.4 GHz). However, it also noted that this band is being considered at WRC-19 as one of the bands that could potentially be globally harmonized for future commercial mobile use.

Current use: The 32 GHz band includes allocations to fixed, radionavigation, space research and inter-satellite services. There is currently no deployment in the band.

International context: The 32 GHz band is used for backhaul applications by many European markets, the majority being medium- and high-capacity systems. As discussed above, this band is being considered under WRC-19 as one of the bands for the future development of IMT. However, current studies indicate there may be issues involved with sharing between IMT and radionavigation services in the band.

Potential equipment ecosystem: There are currently backhaul standards and equipment developed for Europe.

Summary of comments

The band was supported for different uses by a number of stakeholders. Bell and Nokia supported flexible use of the band and Bell suggested a release in 2025. Rogers recommended that ISED wait for the outcome of WRC-19 to consider any further changes to this band and, in the short term, Rogers supports the use of this band exclusively for fixed backhaul applications, while recognizing that the band has potential for commercial mobile and fixed services. TELUS opposed the use of this band for two-way backhaul only and recommended that it be kept unencumbered and available for future flexible use. Ericsson supported fixed use of the band. RABC noted that the adjacent 31.3-31.8 GHz is allocated to EESS/space research service (passive) as well as Radio Astronomy and the service would be seriously affected by unwanted emissions if appropriate consideration is not used in deployments of any services.

Discussion

Given the identified need for backhaul spectrum in this band, ISED will move forward as outlined in the Backhaul Decision to make this band available for backhaul use and plans to release it in late 2019. Thus, ISED considers this band as Priority 1 for backhaul use. Following the conclusion of WRC-19, ISED will assess potential commercial mobile use in this band. Therefore, ISED considers any other use of this band as Priority 3.

8.3.5 40-43.5 GHz, 45.5-50.2 GHz and 50.4-52.6 GHz

In the Outlook Consultation ISED indicated that it would take into account the decisions of WRC-19 when considering future spectrum releases for these bands. However, based on the discussions at WRC-19 ISED proposed that these bands could potentially be released for commercial mobile, fixed and/or satellite services in the next five years.

Current use: The bands 40- 43.5 GHz, 45.5-50.2 GHz and 50.4- 52.6 GHz are currently used for a variety of satellite and fixed services.

International context: As discussed above, these bands are being considered at WRC-19 for different services and the United States and European countries have begun to examine and make decisions on future uses of these bands.

Potential equipment ecosystem: There is already equipment available for fixed and satellite services for these bands. It is expected any bands identified for IMT at WRC-19 will be included in the 3GPP 5G standards.

Summary of comments

Bell, Hughes Canada, Intelsat, Nokia, RABC, Rogers, SaskTel, SES, Telesat and TELUS agreed that these bands should be released in the next five years, however, they proposed different services and different priorities for the various bands. Shaw was of the view that ISED could consider the 37-43.5 GHz band for release in the next five years and could consider

the 47.2-48.2 GHz band in order to harmonize with the FCC's recent decision. Bell was of the view that the three bands should, where feasible and compatible with existing use, be made available for flexible fixed and mobile use. SaskTel agreed that these bands are candidates for future commercial mobile services.

Rogers and TELUS indicated that all three bands had potential for commercial mobile, fixed and satellite use. Intelsat requested that ISED guarantee access to these bands by satellite operators for gateways and satellite fixed and in-motion terminals arguing that, with the increased capacities demanded for satellite broadband, these bands are important components of the FSS and 5G ecosystem. The RABC was of the view that these bands would be important for HTS and LEO constellations and as such some spectrum should be dedicated for FSS use. The RABC also suggested that some portions of these bands should be allocated to shared use by FSS and terrestrial services, and noted that allocations to EESS and space research in some of these bands would need to be protected. SES agreed with the RABC view, and further requested that ISED make all these bands available for FSS use. Shaw recommended that ISED ensure that there is sufficient spectrum available for commercial mobile services in the mmWave bands, and that ISED should set the appropriate conditions for sharing between commercial mobile and FSS. Telesat was of the view that ISED should take similar steps as the FCC to identify dedicated satellite spectrum in these bands and allow shared use for gateways in the remaining spectrum. In their reply comments, the Satellite Operators Coalition proposed that ISED should dedicate 40-42 GHz and 48.2-50.2 GHz for satellite use including allowing ubiquitous terminals and that 42.5-43.5 and 47.2-48.2 GHz could be made available for shared use of terrestrial systems and licenced earth stations. Hughes supported shared use for 50.4-51.4 GHz and GSO FSS use for 51.4-52.4 GHz.

Bell indicated its view that 40-42.5 GHz is a medium priority, and that 45.5-50.2 GHz and 50.4-52.6 GHz are low priorities. Rogers considered that all of these bands should be released as a low priority and recommended that ISED wait until after WRC-19 to make any changes to these bands. SaskTel also recommended that ISED wait until after WRC-19 to make any changes to these bands, and indicated that bands released in the United States for commercial mobile should be considered a higher priority as 5G equipment is likely to be available in those bands first. TELUS was of the view that 45.5-50.2 GHz should be considered a high priority and that 40-42.5 GHz and 50.4-52.6 GHz should be considered as medium priorities.

Discussion

There is significant interest in the bands 40- 43.5 GHz, 45.5- 50.2 GHz and 50.4- 52.6 GHz both internationally and domestically for commercial mobile, fixed and satellite use. Recognizing that these bands are still under discussion at WRC-19 and within other countries, ISED considers these bands as Priority 2. ISED will continue to monitor these developments to determine when, and for which services, these bands should be made available.

8.3.6 70 GHz and 80 GHz

The Outlook Consultation proposed that the bands 71-76 GHz (70 GHz) and 81-86 GHz (80 GHz) could potentially be made available for commercial mobile fixed and/or licence-exempt.

Current use: In June 2012, ISED published *SP 70 GHz, Decisions on the Frequency Bands 71-76 GHz, 81-86 GHz and 92-95 GHz*, which designated the 70 GHz and 80 GHz bands for fixed use. The decision also indicated that ISED would issue spectrum licences on a first-come, first-served basis and that all licensees would have shared access to the band subject to a future consultation on fees and the development of the technical requirements. As an interim measure, ISED began issuing standard site-specific licences in May 2017, following the release of SRSP-371.0, *Technical Requirements for Fixed Line-of-Sight Radio Systems Operating in the Bands 71-76 GHz and 81-86 GHz*.

International context: The 70 GHz and 80 GHz bands have been made available for fixed services on a shared basis in the United States, United Kingdom, some European countries and Australia. In addition to fixed use, as discussed above, these bands are also being discussed at WRC-19 for future commercial mobile use.

Potential equipment ecosystem: There is already equipment available for backhaul applications using these bands. It is expected that any bands identified for IMT at WRC-19 will be included in the 3GPP 5G standards.

Summary of comments

There was support for releasing the 70 GHz and 80 GHz bands for different services and applications. Bell supported commercial mobile, fixed and licence-exempt use indicating its view that these bands are a high to medium priority for release. Huawei Canada, Nokia and Québecor indicated that these bands should be made available for commercial mobile to support 5G deployments. Huawei Canada was of the view that there are strong applications for 5G services with integrated backhaul in these bands. Nokia specified that it believes that sharing is feasible between mobile and fixed stations in these bands. SaskTel and TELUS recommended that ISED wait until after WRC-19 before making changes to these bands. TELUS requested that ISED keep these bands unencumbered for future mobile use and was of the view that these bands were a medium priority for future release. BCBA, Microsoft and WiFi Alliance supported making the bands available for licence-exempt use. DSA supported the release of 70 GHz for licence exempt use. Ericsson, Rogers and Shaw supported backhaul use. Rogers did not support changes to make these bands available for commercial mobile or licence-exempt use, and indicated that this band is a low priority. The RABC was of the view that over the longer term these bands will be required for backhaul and satellite and recommended in the near term deferring changes to allow commercial mobile use. The RABC also requested that ISED protect the adjacent EESS use in band 86-92 GHz. Intelsat and Telesat pointed out that these bands are also allocated to satellite services and were of the view that ISED should ensure that these bands would be available for satellite terminals and gateways in the future. SES supported Intelsat and Telesat's comments in its reply comments, further requesting that some spectrum be reserved for FSS use in these bands.

Discussion

As discussed in section 7, ISED intends to optimize the use of spectrum and will seek to allow spectrum sharing whenever feasible. The propagation characteristics of the 70 GHz and 80 GHz bands are ideal for sharing between different services. ISED also recognizes that there is immediate demand for backhaul in these bands and there may be a demand in the future for commercial mobile, satellite and licence-exempt uses. These bands are considered as Priority 1 for backhaul with a potential release in mid-2020, following a consultation on the conditions of licence. Any other use of these bands is considered as Priority 3 depending on domestic requirements and international developments.

8.3.7 Bands above 95 GHz

The Outlook Consultation proposed that the bands above 95 GHz could be made available for licence-exempt applications and fixed services.

Current use: There is currently very light use of these bands in Canada.

International context: As discussed above, the FCC consulted on the potential for making these bands available for licence-exempt use.

In Europe, the European Telecommunications Standards Institute has formed an industry specification group on millimetre wave transmission, which is conducting studies which consider bands above 95 GHz. In addition, the European

Communications Office has initiated work on developing ECC recommendations and reports to facilitate the implementation of backhaul use in portions of 92-115 GHz and 130-174 GHz.

The frequency range 275-450 GHz is being studied under WRC-19 Agenda item 1.15.

Potential equipment ecosystem: ISED is not aware of any equipment that has been made available for the bands above 95 GHz. However, given work under way internationally, an equipment ecosystem is anticipated in the future.

Summary of comments

BCBA, Microsoft and WiFi Alliance supported licence-exempt. Bell and TELUS supported fixed and licence-exempt use with a low priority for release. Huawei Canada supported commercial mobile use with a low priority for release. TeraGo supported commercial mobile use. Nokia supported fixed and commercial mobile. RABC supported backhaul use. Rogers supported fixed use with a high priority for release. Ericsson, TeraGo and Québecor indicated that the bands 92-114.25 GHz and 130-174.8 GHz are being discussed internationally as potential backhaul bands. Rogers also discussed the potential for 130-174.8 GHz equipment being available before 2022.

Discussion

ISED recognizes that there is interest in making spectrum available above 95 GHz for different uses. However, at this time there are no bands that have been made available internationally and there is no current equipment ecosystem. ISED will continue to monitor the international developments of the bands above 95 GHz. At this time ISED considers these bands as Priority 3, and any release of the bands above 95 GHz will only be considered if there are significant changes internationally.

8.4 Other frequency bands

As part of the Outlook Consultation ISED also discussed the potential use of the 13 GHz (12.7-13.25 GHz) band for backhaul and the 7 GHz and 9 GHz bands for EESS. These bands were not further considered in this document as the SRSP which will allow the 13 GHz band to be used by backhaul is nearly complete and changes were made to the CFTA for the 7 and 9 GHz bands which allow their use for EESS. Therefore, these bands are considered to be imminently available and not part of ISED's future planning.

Comments were received on other bands. Medtronic proposed the band 430-440 MHz for licence-exempt, however, this request should be considered through ISED's normal standard development and licensing processes. TELUS and Qualcomm both discussed the band 3300-3400 MHz for flexible use. TELUS also proposed the band 4400-5000 MHz for flexible use and Bell supported this proposal through their reply comments. Both the 3300-3400 MHz and the 4400-5000 MHz bands are heavily used by government services and ISED does not intend to review these bands at this time given the significant amount of spectrum already planned for release for flexible use in this Spectrum Outlook. CCI proposed the bands 1780-1850 MHz, 2025-2110 MHz and 2200-2285 MHz for commercial mobile. These bands are heavily used for fixed services and the bands 2025-2110 MHz and 2200-2285 MHz are crucial for international space and weather tracking applications. ISED does not intend to review these bands at this time given the significant amount of spectrum already planned for release for commercial mobile in this Spectrum Outlook. Cisco proposed a review of the band 7125-7250 MHz to allow for licence-exempt use. This band is currently heavily used for fixed backhaul and ISED is not aware of any changes to this band internationally that will lead to a licence-exempt ecosystem in this Spectrum Outlook timeframe. Therefore, ISED does not intend to review this band at this time. However, ISED will continue to monitor the uses of all of these bands.

8.5. Priority and timing of spectrum releases for 2018 to 2022

This section of the Spectrum Outlook summarizes ISED's priority for each band discussed in sections 8.1 to 8.3. It also provides the anticipated timing for release for those bands that are designated as Priority 1.

Figure 1 illustrates the priority group each band discussed in sections 8.1 to 8.3 has been placed into. In making the determination for each band, ISED has taken into account the policy objectives outlined in section 2, the principles of spectrum release discussed in section 3, and the other considerations outlined earlier in this section. It should be noted that ISED regularly monitors domestic and international developments and, based on the considerations outlined above, may alter its priorities and plans for spectrum release.

Figure 1: Spectrum Outlook priorities

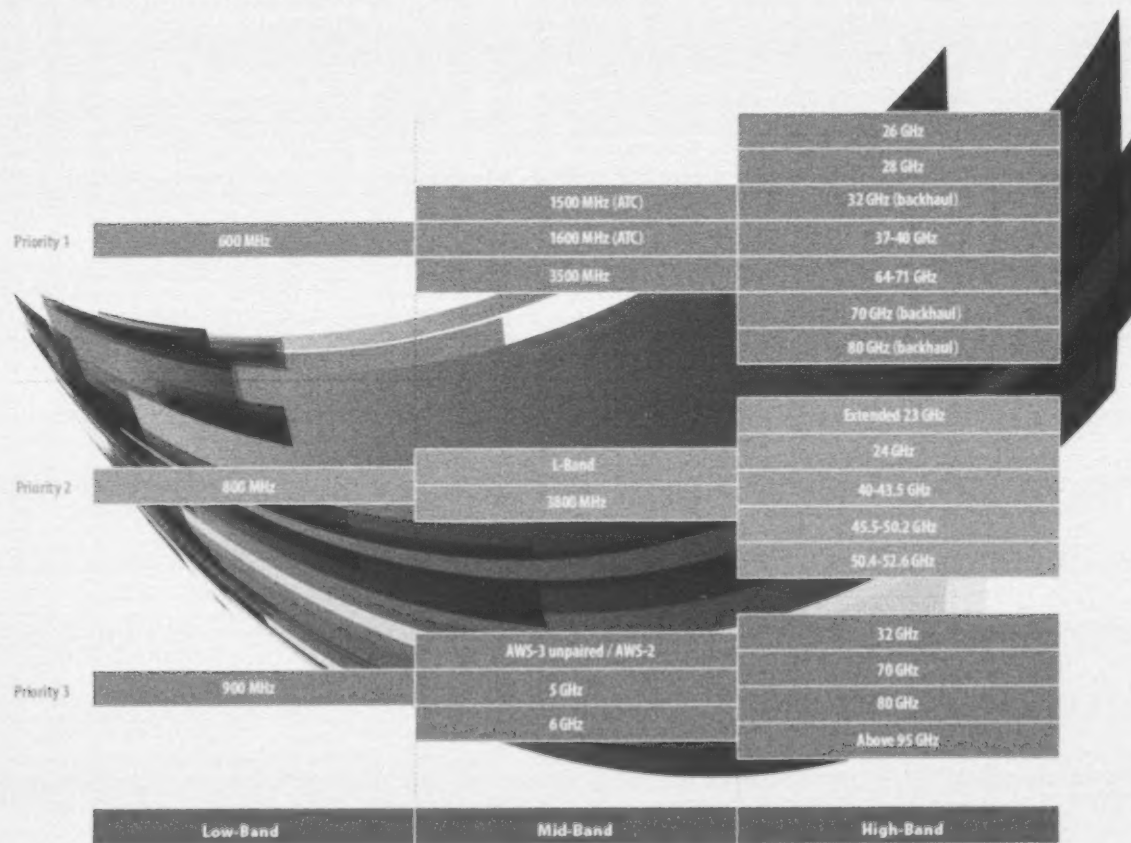
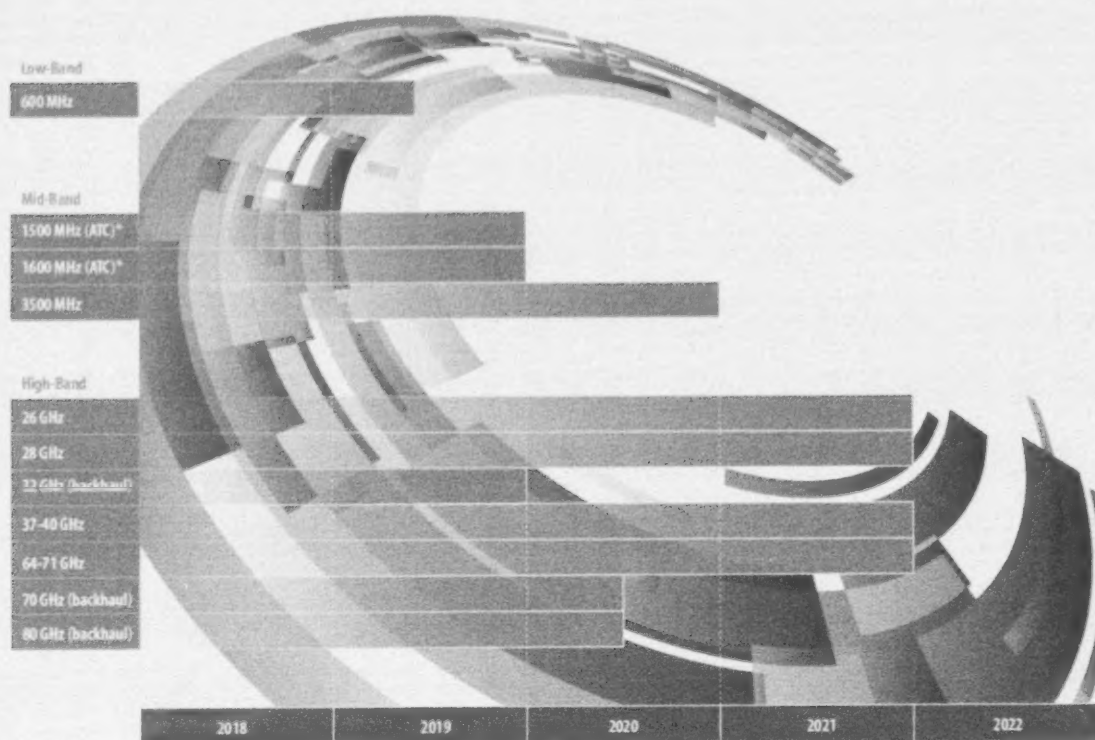


Figure 2 illustrates ISED's anticipated timing for release of each Priority 1 band. It indicates ISED's current assessment of anticipated timing, which may change based on the considerations outlined above. In addition, ISED will conduct public consultations prior to releasing additional spectrum. As such, comments received as part of each consultation process may impact various aspects of release, including timing.

Figure 2: Spectrum Outlook timing of Priority 1 bands



* Anticipated timing refers to review of RP-023

At this time, ISED is not indicating anticipated timeframes for release of bands considered as Priority 2 and Priority 3 due to uncertainty regarding various considerations, such as international developments and equipment availability.

This Spectrum Outlook is intended to reflect ISED's current direction and efforts to provide additional spectrum for commercial mobile services, licence-exempt applications, satellite services and backhaul applications. As such, it may be updated from time to time in order to reflect changing priorities, significant technological changes or international developments.

ISED will have separate and comprehensive consultations before making any specific decisions with respect to these bands. ISED will also assess, at the same time, any competing requirements for spectrum before any decision is made. It is also recognized that the timing of specific decisions will be subject to domestic and international developments.

The observations and conclusions expressed in this Spectrum Outlook are based on the current situation in Canada and abroad, and are therefore subject to change. This Spectrum Outlook is not intended to be a substitute for separate, comprehensive consultations with stakeholders on specific spectrum management issues. For a complete list of recent and ongoing public consultations, please refer to the ISED website.

9. Obtaining copies



All ISED spectrum-related documents referred to in this paper are available on Innovation, Science and Economic Development Canada's Spectrum Management and Telecommunications website.

For further information concerning the process outlined in this document or related matters, contact:

Innovation, Science and Economic Development Canada
c/o Director, Spectrum Regulatory Best Practices
235 Queen Street
Ottawa, Ontario K1A 0H5
Telephone: 613-219-5436
Email: ic.spectrumauctions-encheresduspectre.ic@canada.ca